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„Effectiveness of current vitamin A deficiency programs in Democratic Republic of Congo

A quantitative survey of household characteristics, consumption patterns and agrobiodiversity in farmer families in South Kivu with special emphasis on vitamin A deficiency in infants <5years of age and mothers"

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Michaela Windhager

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1. Introduction

A quantitative cross sectional study was conducted during an internship at Bioversity International in Kampala Uganda from February- June 2016. The data was collected in South Kivu located in the east of Democratic Republic of Congo in October 2015 under HT-CIALCA-Nutrition framework.

Bioversity International is a global research-for-development organization and a member of the Consultative Group on International Agricultural Research (CGIAR) Consortium. Bioversity´s aim is agricultural biodiversity to nourish people and sustain the planet. Further it aims to deliver scientific evidence, management practices and policy options to use and protect agricultural and tree biodiversity to attain sustainable global food and nutrition security. Bioversity International works with partners in low-income countries in different regions where agricultural and tree biodiversity can contribute to improved nutrition, resilience, productivity and climate change adaptation.

The Consortium for Improving Agriculture-based Livelihoods in Central Africa (CIALCA) was created in 2006 by the International Institute of Tropical Agriculture (IITA), Bioversity International, and the International Centre for Tropical Agriculture (CIAT), and funded by the Belgian Directorate General for Development Cooperation (DGD). CIALCA operates in Rwanda, Burundi, and the Democratic Republic of the Congo (DRC) with national partners. Initially, it's research-for-development (R4D) agenda focused on improving crop production technologies in legume and banana-based systems and also on creating an enabling environment for the uptake of these practices [1].

The survey of South Kivu was based on a questionnaire of Humid Tropics CGIAR-Program in CIALCA region about household characteristics, consumption patterns and agrobiodiversity assessment. The questionnaire used was reviewed, a data entry template developed, the data entered and analysed. Afterwards a report was produced and submitted. The data was conducted in two territories of South Kivu. Further details are provided in the third chapter called "Material and Methodology". Based on the household characteristics, consumption patterns and agrobiodiversity, DRC was searched for similar information concerning household characteristics, agrobiodiversity and their consumption patterns to compare it to the data of South Kivu. According to the findings, vitamin A deficiency (VAD) is still one of the major nutritional problems in DRC[2 3 4]. The aim of this dissertation is to find out why VAD remains a public health problem in DRC. To answer that question, the complexity and challenges of VAD and programs tackling this issue will be discussed.

DRC is located in Central Africa. It borders the Central African Republic and South Sudan to the north; Uganda, Rwanda, Burundi and Tanzania to the east; Zambia and Angola to the south; the Republic of the Congo to the west and the Atlantic Ocean to the southwest. It is the second-largest country in Africa (largest in Sub-Saharan Africa) by area and it has a population of over 80 million[5].

The survey was conducted in South Kivu, located in the east of the Democratic Republic of Congo. South Kivu lays in the equatorial climate zone where temperatures are stable throughout the year (20-30°C). The rains in the equatorial zone are abundant, and experiences two maxima in late March and late September, and given the inertia in the heating of the soil, the rainiest months are usually April-May and October-November. The least rainy periods are generally January-February and June-July. It is one of 26 provinces of the Democratic Republic of the Congo. Its capital is Bukavu. South Kivu borders the provinces of North Kivu to the north, Maniema to the west, and Katanga to the south. To the east it borders the countries of Rwanda, Burundi, and Tanzania.

Administratively, the province South-Kivu is divided into eight territories:

1. Fizi (15,788 km²), capital Fizi town;
2. Idjwi (281 km²), this is an island in Lake Kivu;
3. Kabare (1,960 km²),
4. Kalehe (5,126 km²),
5. Mwenga (11,172 km²),
6. Shabunda (25,116 km²),
7. Uvira (3,148 km²), capital Uvira town;
8. Walungu (1,800 km²),

The Data was collected in the territories Kabare and Walungu within the Groupings Mushinga, Burhale, Bushumba and Miti. Table 1 shows the location of the conducted villages. A total of 207 households participated in this study. 104 participants were from the territory Kabare and 103 from Walungu. 96,6% (N= 207) of the respondents were women.

Table 1: Location of conducted villages, groupings and territories

Territory	**Kabare**		**Walungu**	
Grouping	**Bushumba**	**Miti**	**Mushinga**	**Burhale**
Village	Mushunguri	Combo	Karerwa	Mwegerera
			Kalimuzi	

2. Literature Overview

2.1. Vitamin A function, recommendations and its complexity

Vitamin A (retinol) is an essential fat soluble nutrient needed in small amounts for the normal functioning of the visual system; growth and development; and maintenance of epithelial cellular integrity, immune function, and reproduction. These dietary needs for vitamin A are normally provided for as preformed retinol (mainly as retinyl ester) and pro-vitamin A carotenoids[6]. In a mixed diet, the conversion rate of β-carotene to retinol is approximately 12:1 (higher, i.e. less efficient than previously believed). The conversion of the other pro-vitamin A carotenoids to retinol is less efficient, the corresponding conversion rate being of the order of 24:1. Various food preparation techniques, such as cooking, grinding and the addition of oil, can improve the absorption of food carotenoids. Synthetic β-carotene in oil, which is widely used in vitamin A supplements, has a conversion rate to retinol of 2:1, and the synthetic forms of β-carotene that are commonly used to fortify foods, a conversion rate of 6:1[7].

Vitamin A functions at two levels in the body. The first is in the visual cycle in the retina of the eye; the second is in all body tissues systemically to maintain growth and the soundness of cells. The growth and differentiation of epithelial cells throughout the body are especially affected by vitamin A deficiency (VAD). VAD is not simply defined. WHO defines it as tissue concentrations of vitamin A low enough to have adverse health consequences even if there is no evidence of clinical xerophthalmia [6].

Serum retinol concentrations are under homeostatic control due in part to vitamin A´s use in the body for growth and cellular differentiation and because of its toxic properties at high concentrations. Furthermore, serum retinol concentrations are depressed during infection and inflammation because retinol-binding protein (RBP) is a negative acute-phase reactant, which makes status assessment challenging [8].

In addition to the specific signs and symptoms of xerophthalmia and the risk of irreversible blindness, non-specific symptoms include increased morbidity and mortality, poor reproductive health, increased risk of anaemia, and contributions to slowed growth and development. Because these non-specific adverse consequences may occur from other nutrient deficits as well, it is difficult to attribute non-ocular symptoms specifically to VAD in the absence of biochemical measurements reflective of vitamin A status. Vitamin A deficiency causes xerophthalmia, a range of eye conditions from night blindness to more severe clinical outcomes such as keratomalacia and corneal scars, and permanent blindness. It is also associated with an increased risk for measles and diarrhoea in children [9] [10].

VAD can occur in individuals of any age. For children, lack of vitamin A causes severe visual impairment and blindness, and significantly increases the risk of severe illness, and even death, from such common childhood infections as mentioned above, diarrhoeal disease and measles. For pregnant women in high-risk areas, vitamin A deficiency occurs especially during the last trimester when demand by both the unborn child and the mother is highest. The mother's deficiency is demonstrated by the high prevalence of night blindness during this period. The impact of VAD on mother-to-child HIV transmission needs further investigation[6].

However, additional research is needed to clarify the mechanisms of the apparent interaction. VAD is a disabling and potentially fatal public health problem for children under 6 years of age. VAD-related blindness is most prevalent in children under 3 years of age [6]. This period is characterised by high requirements for vitamin A to support early rapid growth, the transition from breast-feeding to dependence on other dietary sources of the vitamin, and increased frequency of respiratory and gastrointestinal infections [11]. Women of reproductive age are thought also to be vulnerable to VAD during pregnancy and lactation because they often report night blindness [6] and because their breast-milk can be low in vitamin A[12].

WHO recommends vitamin A supplementation with a dose of 30 mg retinol equivalents in infants aged 6–11 months and 60 mg retinol equivalents at least twice a year in young children aged 12–59 months living in settings where vitamin A deficiency is a public health problem, [11] with up to 100 countries implementing this guidance [13].

Other possible risk factors for VAD that need to be considered and discussed might be:

1. Consuming most of ones vitamin A needs from pro-vitamin carotenoid sources, since vitamin A from animal-sourced foods is better available for the body.

2. Since vitamin A is fat-soluble, it is more efficiently absorbed into the bloodstream when eaten with fat. Most animal-sourced foods that are rich in vitamin A are also high in fat, but the same doesn't apply to most plant sources of pro-vitamin A.
3. Too small quantities of vitamin A rich foods and a less frequented consumption of vitamin A rich foods can lead to VAD.
4. Periods of general food shortage due to season change, weather (because it effects the harvest), changes in income etc. can decrease the availability of nutritious foods and therefore vitamin A-rich foods.
5. Infectious diseases depress circulating retinol and contribute to vitamin A depletion
6. Enteric infections may alter absorptive-surface area, compete for absorption-binding sites, and increase urinary loss
9. Measles virus infection is especially devastating to vitamin A metabolism, adversely interfering with both efficiencies of utilisation and conservation
10. Severe protein-energy malnutrition affects many aspects of vitamin A metabolism, and even when some retinyl ester stores are still present, malnutrition – often coupled with infection – can prevent transport-protein synthesis, that results in immobilisation of existing vitamin A stores [7].

VAD seldom occurs in isolation of other nutrient deficiencies that also affect growth and may be more limiting. A lack of vitamin A can affect iron metabolism when deficiencies of both nutrients coexist and particularly in environments that favour frequent infections. A study of 2015 concluded that a supplementation with iron can lead to increased bioavailability of pro-vitamin A carotenoids from papaya and its conversion to retinol [14]. Maximum haemoglobin response occurs when iron and vitamin A deficiencies are corrected together. VAD appears to influence the availability of storage iron for use by haematopoietic tissue.
A paper of Lintig in 2012 demonstrated BCMO1 coding for ß-carotene 15,15-dioxygenase as the key enzyme for vitamin A production; a polymorphism in the enzyme that cleaves pro-vitamin A carotenoids to retinal, can cause low serum retinol concentration. Some communities have a higher prevalence of this polymorphism[15]. To

find out whether communities in Africa carry such a polymorphism it can be worth to investigate in high-risk populations. The influence of these polymorphisms has not been investigated on response to prolonged dietary intake of pro-vitamin A carotenoids on population vitamin A status [16].

2.2. Country specific Background information

DRC is amongst other things challenged by a wide spectrum of infectious diseases, a neglected physical and human health infrastructure, conflict in the last decades and the economic collapse of the country. As a consequence, infant mortality rates in DRC are among the highest in Africa [17].

Previously controlled diseases such as African Trypanosomiasis have reappeared, and many areas of the country remain inaccessible due to poor infrastructure or security threats. The health status of the Congolese people ranks among the worst in sub-Saharan Africa after decades of political instability and violent conflict, the breakdown of infrastructure and long periods of economic decline[18]. As UNAIDS points out, “populations fleeing complex emergencies such as armed conflicts generally face destitution and food shortages. Their situation is made worse because they often have no access to health care, either because systems have collapsed or simply do not exist in refugee hosting areas. For example, in the 1998–2001 war in the Democratic Republic of Congo, 80% of the estimated 2.5 million ‘excess deaths’ resulted from malnutrition, communicable diseases and other factors aggravated by the violent conflict” [18]. A MSF survey from 2001 found that in frontline zones like Basankusu “approximately 10% of the total population and 25% of the under-five population had perished in the year before the survey” [17].

Current estimations by the Nutrition Landscape Information System (NLIS) from 2013-2014 for prevalence of food insecurity in South Kivu is 60% (33% in DRC) and 70% lack access to adequate food. The most vulnerable of all poor people are young people and women, who are the primary agricultural producers and processors. Poverty is most severe in the Congo's rural areas where people are more isolated and there is little investment.

Despite the country’s huge potential, there are several causes of the poverty in the Congo:

- microfinance in rural areas is almost non-existent;
- low agricultural productivity as a result of traditional cultivation methods, insufficient use of inputs such as improved seeds and planting materials and fertilizers;
- vehicles, access roads, crossings and navigation channels are in very poor condition which makes transport and other costs high;
- difficulties in marketing because of weak collection and distribution organizations, basic processing equipment and a frail communication system connecting producers, traders and consumers[19].

Household characteristics

The National Agricultural Investment plan 2013-2020 of the DR Congo states that the DR Congo is one of the African countries with the highest incidence of poverty of 71.34% (Ministère de l’agriculture et Développement rural, PNIA 2013-2020) [20].
Health expenditures of individuals in DRC were collected by second demographic and health survey in the Democratic Republic of Congo (EDS-RDC II) in 2010. The results (in US dollars) show that $20 for outpatient care and $7 for hospitalizations are spent annually. A household spends $376 in urban areas and $128 in rural areas annually (on average $206) [3]. It also revealed that 81% of married women age 15-49 were employed in the 12 months before the survey, compared to 97% of married men age 15-49. Most women claim to earn less than their husbands. In DRC, 60% of women participate in decisions about major household purchases, 46% participate in decisions about her health care and 26% say that they do not participate in any decisions [3].
According to EDS-RDC II, an average household in DRC consists of 5.3 members and 25% of households are headed by women. 14% of households have access to electricity. Currently, 49% of households (32% in rural areas and 85% in urban areas) have access to an improved source of drinking water. To obtain drinking water 51% must travel 30 or more minutes. 46% use non-improved sanitation facilities and in rural areas, 20% of households do not have any sanitation facility, compared to 4% of households in urban

areas. In rural household 74% own farm land, compared to 29% in urban households. According to the Nutrition Landscape Information system (NILS 2017), 15% of women and 4% of men between 15-49 years of age have no education. In contrast, 48% of women and 74% of men have secondary or higher education[21].

Agrobiodiversity and food security

The current Global Food Security Update in 2017 showed that the recent conflict in the Democratic Republic of Congo has increased the number of food insecure population, with 5.9 million people (8% of the population) in IPC (Integrated food security phase classification) phase 4 (emergency) and phase 3 (crisis) [22] and 13% of the population in South Kivu are in IPC Phases 3 and 4 [23] which could have been preventable. Also natural disasters and animal/ plant diseases reduce food availability and therefore pushing up prices. Among others, maize and cassava flour prices remained above the three year average in markets monitored by WFP and FAO and the price of vegetable oil increased in the DR Congo by 13% [24]. In DRC 63% of household expenditure goes to food and agriculture remains largely at subsistence level. The global food security update predicts the agricultural production as likely to be stable in early 2017, providing households with food until April, yet it will leave many territories in IPC Phase 2 or Phase 3 [22]. According to MICS 2010, 33% of DRC´s households and 60% of the South Kivu´s households are food insecure [25]. 90% of arable land is not cultivated, mostly due to insecurity preventing access to fields and markets [23].

The most consumed foods by the households are in general, cassava and palm oil, 85% and 96% respectively and on average 4 to 5 days a week. Fewer households consume cereals (81%), vegetables (77%) and meat, poultry, fish and seafood (74%) and only on average 3 times a week. Other foods such as sugars and sugary products and milk and dairy products are consumed not even by half of the households and if consumed, only once a week [25].

According to Agricultural Investment Plan traditional agriculture, also known as family farming, counts for more than 80% of national production. The small farms use, rudimentary tools and the workforce is composed mainly of members of the household. Peasant households cultivate mainly to ensure food self-sufficiency of their families and have a small production, but relatively diverse consisting of cassava, maize, rice, vegetables, fruits [20].

The foods from own household production, are roots and tubers (63% of households), fruits (50%), corn (48%), vegetables (46%) and oilseeds (70%). Other foods mainly obtained from markets (especially in urban areas) are milk (93%), sugar (91%), rice (70%), palm oil (69%), meat (68%) and legumes (58%). Own household production, and other food sources are unable to meet the food needs of the majority of households, leaving the country still in a state of food insecurity. Cassava is by far the most important food crop in the DR Congo[25]. Estimated consumption of Cassava in DRC is 200g/day for children between 4-6 years and 400g/day for women [26]. Banana is the second culture in the country after cassava from the point of view of production and demand. Cereals come in third with 74% corn, 23% rice, 3% millet and 1% wheat [25].

2.3. Nutrition, health status of mothers and infants

The mortality of children <5years is currently (2017) around 10% in DRC. This data varies by province (South Kivu has the highest under-five mortality with 14%) and by mother´s education (122 deaths per 1,000 live births for children born to mothers with no education versus 93 for children born to mothers with secondary or higher education) [3].

Vitamin A deficiency (VAD) is a serious public-health issue in countries with few resources, such as DRC. Combating this problem has been a priority by the World Health Organization. According to Harvest Plus an estimated 100 million people in Sub-Saharan Africa are at higher risk of going blind due to Vitamin A deficiency. The Vitamin and Mineral Nutrition Information System (VMNIS) of WHO shows an overall prevalence in DRC of 61,1% of VAD (serum plasma retinol concentration of < 0,7 µmol/l) and 21,6% had a serum plasma retinol concentration even below 0,35 µmol/ [4]. 16% of pregnant women in DRC are deficient in Vitamin A [6]. The prevalence of clinical vitamin A deficiency in women (history of night blindness during most recent pregnancy) is unknown [21].

A prevalence of VAD higher than 20% in preschool-age children (defined as ages 6-59 months) or pregnant women in the population with low serum retinol (0.70 µmol/l or below) can be seen as a severe public health problem[27]. VAD is mainly caused by insufficient Vitamin A intake, it is also associated with diseases like malaria, but It is not certain whether this represents pre-existing vitamin A deficiency, a contribution of malaria to vitamin A deficiency, or merely an acute effect of malaria on retinol metabolism or binding [28].

A study with a nationally-representative sample of 2,696 preschool children living in Congo, examined during August-September 2003 (end of dry season) to determine the rates of vitamin A deficiency was conducted. This study period was chosen because vitamin A status was assumed to be the lowest level at that time of the year. It was found that vitamin A status of 30% of the study children was critical, probably due to poor health status and low rates of consumption of vitamin A-rich food. The prevalence in this study area of children <5years was found to be 50%[29]. According to UNICEF, children show sometimes no external signs of vitamin A deficiency but live with dangerously low vitamin A stores, leaving them vulnerable to infection and with reduced immunity to fight common childhood diseases. Because of technical and financial constraints, such as limited ability to transport and store biological samples or lack of laboratory facilities, many countries have not been able to assess the true level of deficiency.

WHO recommends that children receive nothing but breastmilk (exclusive breastfeeding) in the first six months and complementary foods should be introduced when a child is six months old to reduce the risk of malnutrition. The Infant and Young Child Feeding (IYCF) practices recommend that breastfed children age 6–23 months be fed foods from four or more food groups daily. Non-breastfed children should be fed milk or milk products in addition to foods from four or more food groups. IYCF also recommends that breastfed children age 6-8 months should be fed at least twice a day, if the breastfed child is 9-23 months old at least three times a day. For non-breastfed children age 6-23 months, the minimum number of feeding times is four times a day[3].

The latest data from Nutrition Landscape Information System (NLIS) from 2013-2014 show that 47,6% of children <6months are exclusively breastfed in DRC which means a steady increase since 1995[21].

The survey results of EDS-RDC II show that only 9% of breastfed children and 2% of non-breastfed children are being fed in accordance with ICYF recommendations. 48% of children <6months of age are exclusively breastfed. 45% of children in DRC and 62% of children in South Kivu received full vaccination, compared to 6% of children in DRC did not receive any vaccinations. EDS-RDC II carried out anaemia testing in half of households and found that 60% of children age 6-59 months are anaemic. 70% of children age 6-59 months received a vitamin A supplement in the six months before the survey of EDS-RDC II. Additionally, 82% of children age 6-23 months ate foods rich in vitamin A during the 24 hours before the survey. Moreover, 27% of women who gave birth in the five years before the survey received a vitamin A supplement postpartum.

According to WFP 2012 about 70% of the population lacks access to adequate food, while 1 out of 4 children is malnourished (WFP, 2012). 87,7% of the population in DRC live from less than 1$ per day, and 50,4% are below minimum level of dietary energy consumption[21]. The level of food insecurity is worse in rural areas compared to the urban areas [25].

The child mortality rates in DRC are among the highest in the world. The Demographic and Health Survey of DRC 2013-14, claims 8,1% of children <5yrs are wasted (WHZ <=2) which means they are too thin for their height and suffer from acute malnutrition. 42,6% are chronically malnourished and show signs of stunting (HAZ <=2), in North and South Kivu and Kasaï provinces it is around 53%[23]. 23,4% of children <5years are underweight (WAZ < =2), and 23% are severely stunted[21]. Stunting seems to be related to mother education since stunting decreases as the mother's level of education increases; 51% of children whose mothers have no education are stunted, compared to 13% of children whose mothers have more than secondary education.

Among women age 15-49, 38% are anaemic. Overall, 14% of women have a BMI less than 18.5, which indicates chronic undernutrition. 13,7% are overweight or obese (BMI >= 25) [3] [21].

A cross sectional survey published in 2016, recruited 744 mother-child pairs from South Kivu and Congo Central to determine anaemia and micronutrient status. Vitamin A (RBP) deficiencies were overall very low with <5% and 10% in children. The prevalence of anaemia was unexpectedly low [30].

2.4. Projects for dietary diversification and improvement, to fight Vitamin A deficiency

To tackle VAD in DRC through programs and interventions, it is needed to look at the 4 dimensions of food security and nutrition, i.e. availability, access, stability and utilization[31]. But also at compliance and perspectives of the targeted communities on such interventions. A study from 2013 as a part of a multi-country research program initiated by the World Health Organization's Special Programme for Research and Training in Tropical Diseases (WHO/TDR) aimed to explore the perceptions of poor urban communities of the capital Kinshasa (capital of DRC) with regard to health issues in general as well as their experiences and expectations concerning facility-based health services and community-oriented health interventions. This study shows through focus group discussions that poor urban communities seem to perceive an overall lack of transparency and communication, that leads to a general lack of trust in the health authorities, health care providers and the channels through which health interventions are provided. The incapacity of some community health workers to provide adequate answers to the community's questions about certain interventions also does little to instil confidence. All the focus group discussants seemed to agree that community-oriented health interventions were (in principle) beneficial either to their children or to themselves. But, paradoxically, they also highlighted several factors that underlie a general reluctance from the population to accept such interventions, such as lack of information regarding the purpose of the interventions as the main reason for reluctance, as the population does not feel involved in their process. Communities also perceive the high out-of-pocket cost of health services as a major obstacle when seeking access to good quality health services [32].

Community participatory approaches, which involve the targeted communities in the process of planning and implementation of programs, have shown to be more likely to ensure that such public health strategies gain community support, foster feelings of community ownership and significantly improve the access of rural African communities to essential health interventions. A key factor in such a process is to verify that the proposed intervention addresses a health issue that is acknowledged and considered relevant by the community, therefore it is important to improve the overall understanding of health issues and the community demand of health services [32]. Such an assessment would be needed for rural communities as well due to the differences between rural and urban areas.

Biofortification and selective breeding of staple foods

Biofortification is the idea of breeding crops to improve staple crops for mineral or vitamin content as a way to address malnutrition in developing countries. This can be done either through conventional selective breeding, or through genetic engineering. It differs from ordinary fortification because it focuses on making plant foods more nutritious as the plants are growing, rather than having nutrients added to the food after it has grown. There are multiple advantages about biofortification, such as capitalizing on the regular daily intake of a consistent and large amount of food staples that are predominate in the diets of the poor, by all family members. It is also a one-time investment, since the seeds fortify themselves and germplasm can be shared internationally. Once in place, the biofortified crop system is also highly sustainable, because improved varieties will continue to be grown and consumed year after year without the attention of the government and international funding for micronutrient issues. Biofortification reaches undernourished populations in relatively remote rural areas with limited access to commercially marketed fortified foods that are more readily available in urban areas.

Projects for biofortification in DRC are mainly supported by Harvest Plus, such as bananas/plantains, cassava and maize that have been conventionally bred to be rich in Vitamin A and released/available for farmers in Democratic Republic of Congo [33]. The goal of Harvest Plus is that more than 1.2 million Congolese farming households will be growing biofortified crops by 2018. They work with private farmers, cooperatives, and non-governmental partners to produce and multiply stems and seed of released varieties for delivery to farmers. A payback system ensures that poor farmers receive free stems or seed, which they repay in kind upon harvest. The partnership of Harvest Plus with public and nongovernmental organizations trains farming households in crop management, nutrition, post-harvest handling, and marketing. Biofortified cassava provides up to 40% of daily vitamin A needs, it is high yielding and virus resistant. In Africa, white or yellow fleshed varieties of cassava that are low in beta-carotene are preferred. The International Potato Centre with the support of Harvest Plus, has crossed these with orange-fleshed varieties that are naturally very rich in beta-carotene to produce new orange-fleshed varieties that are better suited to African tastes and also resistant to disease and environmental stress.

Fortification of staple food

Food fortification is the practice of deliberately increasing the content of essential micronutrients (including trace elements) in a food with the aim to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health[7]. DRC fortified wheat flour voluntarily [34].

There are three types of fortification approaches available:

1) Mass (usually compulsory), fortification of one or more staple foods that are regularly consumed by the population in sufficient amounts;

2) Voluntary, market driven, fortification of one or more industry products;

3) Targeted fortification using especially designed fortified foods that are targeted to specific groups, such as preschool and school children [7].

There is also point-of-use fortification referring to the addition of vitamins and minerals in powder form to energy-containing foods at home or in any other place where meals are to be consumed, such as schools and refugee camps. Micronutrient powders are single-dose packets of vitamins and minerals in powder form that can be sprinkled onto any ready to eat semi-solid food consumed at home, school or any other point of use added to foods either during or after cooking, or immediately before consumption, without the explicit purpose of improving the flavour or colour and without changing their usual dietary habits. Point-of-use fortification with micronutrient powders can be targeted to specific populations so that the number and amount of micronutrients can be tailored to meet the target groups' needs without increasing the risk of excessive intake among other population groups. The composition per dose is 10 to 12.5 mg of elemental iron, 300 µg of retinol and 5 mg of elemental zinc; with or without other micronutrients to achieve 100% of the recommended nutrient intake (RNI). WHO recommends that appropriate complementary feeding should start from the age of 6 months, with continued breast feeding up to 2 years or beyond. Similar to vitamin A supplementation, programmes providing micronutrient powders containing vitamin A for point-of-use fortification require active participation from the target population in order to achieve high coverage and regular and appropriate use.

Potentially suitable staple food vehicles for vitamin A fortification in public health programmes include refined sugar, edible vegetable oils and fats, cereal grains (rice); wheat, and maize flours; condiments and seasonings; and powdered or liquid milk. These foods should be regularly consumed in significant amounts by the majority of the target population for purposes of public health programmes.

Dietary diversification and improvement of vitamin A intake

Dietary diversification involves improvements in dietary practices through community education and other means to improve intake of vitamin A-rich foods and enhance its absorption and utilisation in the body. Maintaining such a diet may be difficult all year-round, particularly for the most vulnerable segments of the population in resource-poor settings.

The sight and life foundation implements malnutrition programs and strategies amongst others such as:

1. Ensuring regular access to foods that are naturally rich in vitamin A (feeding programmes for preschool-aged children)

2. Encouraging exclusive breastfeeding, as breast milk is a very important source of vitamin A for infants

3. Showing people how to grow plants rich in vitamin A throughout the year, and how to store and cook them, is the most sustainable long-term food-based approach

4. If a family can also keep chickens then this improves their protein intake (RBP), and egg yolk is also an excellent source of vitamin A.

These strategies of sight and life are mainly implemented in South Africa [35]. No official program implemented in DRC of this kind was found.

Vitamin A supplementation

The World Health Organization (WHO) recommends that all children aged 6–59 months should receive supplements every 4-6 months if they live in a community where VAD is a public health problem. Vitamin A supplementation of new-borns and children aged 1–5 months is not yet recommended (Table 2), instead WHO recommends exclusive breastfeeding in the first 6 months. Vitamin A supplementations are not routinely recommended for pregnant women, as high-dose vitamin A from supplements may cause harm to the developing baby. Instead, pregnant women are encouraged to meet their increased requirements by eating enough vitamin A-rich foods.

The data on whether children received vitamin A supplementation in DRC vary. According to NLIS in 2017 99% of all children received one and 98% two high-dose vitamin A supplementation in the year 2013 in DRC [21]. The demographic health survey of 2014 says coverage was 70% of the surveyed children and a Multiple Indicator Cluster Survey (MICS2) in 2001 found only 11,5 % of one-year old children that received vitamin A supplementation during the previous 6 months [36] [3]. However, this data shows an improvement in the prevalence of vitamin A supplementation over the last decade.

Some efficacy trials in developing countries since 1994 suggest that vitamin A capsules have in most cases no impact on mortality of children and do not reduce VAD, estimated by low serum retinol. But VAD can be more effectively reduced through food-based approaches, including fortification, and through regular low-dose supplementation[37].

Table 2: WHO´s recommendations for vitamin A supplementation

The WHO´s vitamin A supplementation recommendations based on evidence to reduce infant and maternal morbidity and mortality as of 2013 [38]	
Age group and vitamin A dosage in IU	Frequency
Neonatal Not recommended	Not recommended
Age 1-5 months	Not recommended
Age 6-11 months 100,000 IU	One-time dose
Age 12-59 months 200,00 IU	Every 4-6 months
Postpartum women	Not recommended
Pregnant women 10,000 IU 25,000 IU	Routinely not recommended Daily in at-risk areas for night-blindness Weekly in at-risk areas for night-blindness

3. Material and Methodology

A cross-sectional study was carried out using a structured questionnaire about household characteristics, consumption patterns and agrobiodiversity administered in a face-to-face interview to caregivers of children between 5-33months of age in October 2015.

The study population consisted of 207 caregivers of children 5-33 months of age in farmer families in October 2015. The questionnaires were administered by field technicians. Diagnoses about the child´s skin and hair condition and whether the child had oedema were made also by the field technicians who were briefly informed how to assess the conditions.

Measures

The structured questionnaire comprised four parts: socio-demographic characteristics of the household, nutrition, health and agrobiodiversity. The socio-demographic section collected information on the age, education status, household income, source of income, hunger among all household members, health facility. The nutrition and health section collected information about the current health and nutrition status of mother and child (5-33months), background information of mother and child like age, weight and height. A 24h-Recall of mother and child, breastfeeding habits, immunization of the child were assessed. The agrobiodiversity assessment consisted of farm land details (farm ownership, crops grown, species grown, domesticated animal species and wild or semi wild plants, animal and aquatic species gathered, hunted, trapped or fished).

To classify the child´s nutritional status ENA for SMART Program was used. It converts weight, height and age of child (months) into weight-for-age z-score (WAZ), weight-for-height z-score (WHZ) and height-for-age z-score (HAZ). Every child´s full birth date, weight and height was measured and therefore not excluded from anthropometric indices.

ENA for SMART validates the plausibility of the entered data and gives out an automatic report. Since the software cannot explain why children are malnourished or mortality rates are high, the results of the survey have to be complemented with other information. The z-score calculation is identical to other programs.

-Stunting (Height-for-age): an indicator of linear growth retardation and cumulative growth deficits in children (Chronic malnutrition).

-Wasting (Weight-for-height): measures body mass in relation to height and describes current nutritional status (acute malnutrition)

-Underweight (Weight-for-age): a composite index of height-for-age and weight-for-height. It takes into account both acute malnutrition (wasting) and chronic malnutrition (stunting), but it does not distinguish between the two[39].

The measurements were given a score shown in Table 3.

Table 3: Assessment and classification of weight-for-height, height-for-age, and weight-for-age based on Z-scores*

Score	Definition	WHZ*	HAZ*	WAZ*
1	Adequately nourished	-2<z-score>+2		
2	Moderately malnourished	-3<z-score>-2		
3	Severely malnourished	< -3		
Score	Classification/Definition			
1	Well-nourished	All 3 anthropometric indices* are >= -2		
2	Marginally malnourished	1 out of 3 anthropometric indices* are < -2		
3	Moderately malnourished	2 out of 3 anthropometric indices* are < -2		
4	Severely malnourished	All 3 anthropometric indices* are < -2		

**Anthropometric indices WHZ= Weight-for-length Z-score; HAZ= Length-for-age-score; WAZ= Weight-for-age-score*

Anthropometric classifications were based on global standards: <−3SD, <−2SD and ≥−2SD. Children whose HAZ, WAZ and WHZ were below minus two standard deviations (−2 SD) from the median of the reference population were considered as stunted, underweight and wasted. A SD below three means the child is severely stunted, underweight and wasted respectively. The three anthropometric indices were combined to determine the overall nutritional status. This variable was named „classification of WHZ, WAZ, HAZ". A child with all three anthropometric indices <−2SD or ≥−2SD was classified as severely malnourished or well-nourished respectively. If two of the three anthropometric indices were <−2SD, the child was considered moderately malnourished and when one of the three anthropometric indices was <−2SD, the child was considered marginally malnourished. The three anthropometric indices were also assessed individually.

Further the body mass index (BMI kg/m2) of the mothers was assessed and given a score according to WHO references for BMI, described in Table 4.

Table 4: Definition of body mass index (BMI) according to WHO classifications

BMI	Definition	Score
<18,5 kg/m2	Underweight	1
18,5-24,9 kg/m2	Normal healthy weight	2
25-29.9 kg/m2	Overweight	3
>=30 kg/m2	Obesity	4

The household hunger score was assessed by the use of Household Hunger Scale (HHS)[40]. A HHS of 0-1 indicated little or no hunger, 2-3 moderate hunger and 4-6 severe hunger in the HH. A women´s dietary diversity score (WDDS)[41] was calculated by summing the number of 9 food groups consumed by mothers during last 24 hours (table 6). The food groups „sweets & sugars“, „fats & oils“ and „condiments & spices“ were excluded to provide descriptive information of the nutrient density of the diet in the survey population. This reflects a judgement that the risk of falsely inflating food group diversity is more serious than the risk of excluding these items and underestimating diversity for the relatively small number of instances where consumption of these items might be more substantial[42].

The DDS for the survey children[43] was used to calculate the DDS of the survey children (Table 5). Both DDS were calculated without considering a minimum intake for the food group.

Table 5: Food groups of women´s dietary diversity score (WDDS) and dietary diversity score for children (DDS children)

Food groups for WDDS[41]	DDS for children [43]
Starchy staples (cereals, white roots, tubers)	Grains, roots or tubers
Dark green leafy vegetables	Vitamin A-rich plant foods (including dark green leafy vegetables)
Other vitamin A rich fruits and vegetables	Other fruits and vegetables
Other fruits and vegetables	Meat and fish
Organ meat	Eggs

Meat and fish	Pulses, legumes and nuts
Eggs	Milk and milk products
Legumes, nuts and seeds	
Milk and milk products	

There are no established cut-off points for WDDS in terms of number of food groups to indicate adequate or inadequate dietary diversity[41]. Because of this it is recommended to use the mean score or distribution of scores for analytical purposes and to set programme targets or goals[41]. Therefore, a target was established by taking the average diversity of the 33 percent of those participants with the highest diversity (upper tercile of diversity) to set a goal for the next assessment. The cut-off point for the children´s DDS is 4, because WHO found an association between a DDS of 4 and better quality diets for both breastfed and non-breastfed children [43].

Further the proportion of participants who consumed vitamin A rich food were assessed (Table 6).

Table 6: Vitamin A and corresponding food groups in the dietary diversity questionnaire

Vitamin A sources: Plant-based
Vitamin A rich vegetables or tubers
Dark green leafy vegetables
Vitamin A rich fruits (e.g. mangos, papayas)
Food group with red palm oil or products made from red palm oil if appropriate
Vitamin A sources: Animal-based
Organ meat
Eggs
Milk and milk products

**The term vitamin A is used in this section for simplicity. It indicates foods containing retinol and foods of plant origin that contain retinol precursor carotenoids*

The following indicators were derived for consumption of vitamin A rich food groups:

- Percentage of individuals/households consuming plant foods rich in vitamin A (vitamin A rich vegetables and tubers, dark green leafy vegetables, or vitamin A rich fruits).
- Percentage of individuals/households consuming vitamin A rich animal source foods (organ meat, eggs or milk and milk products).

- Percentage of individuals/households consuming either a plant or animal source of vitamin A (vitamin A rich vegetables and tubers or dark green leafy vegetables or vitamin A rich fruits or organ meat, or eggs, or milk and milk products).

The indicators above are calculated by summing the number of households or individuals who consumed any of the food groups listed in the questionnaire and then dividing by the total sample size of the survey.

In general, low percentages of households or individuals consuming food groups containing these micronutrients on a given day may be indicative of seriously inadequate diets that lead to morbidity related micronutrient deficiencies. As with the dietary diversity mean score, percentages of those consuming micronutrient rich food groups can be used as one-time measures of a population or sub-populations, for ongoing monitoring or to assess changes in diet such as before and after an intervention. Sub-groups can also be compared, for example communities undergoing a nutrition intervention compared with control communities[41].

The questionnaire was prepared in both French and English. The tool was administered in French and all the data entered in English.

Data analysis

The data were entered into SPSS version 22 (IBM SPSS Statistics 22) for analysis.

Responses to the open-ended question on support most needed were grouped following broad answer categories. The frequency distribution of all closed-ended variables was examined to check for any outliers and to see the overall distribution.

The new cut-offs recommended by the WHO for data exclusion were used. Thus, data were excluded if a child's HAZ was below –6 or above +6, WAZ was below –6 or above +5, WHZ was below –5 or above +5, because these extreme values were most likely a result of errors in measurement[39].

Furthermore simple descriptive analyses were used to describe the characteristics of the study population. Cross tables were performed to analyse relationships between several variables. Results were interpreted as statistically significant when $p < 0.05$.

4. Results and Discussion

Each section discusses the data found in the conducted survey and approaches to tackle public health obstacles. Every result is calculated from 207 participants, otherwise the number of included participants will be mentioned as N=x.

4.1. Nutritional and health status of reference child and mother

This section discusses the relation between VAD and the results on breastfeeding as an important source of vitamin A, anthropometric measures as signs of malnourishment and care-seeking behaviour in case of infections and sickness.

4.1.1 Breastfeeding and feeding practices

Literature shows that breastfeeding protects infants from VAD, but on the contrary breastfeeding women have a higher need for vitamin A[12]. In this survey, 47,8% children have been exclusively breastfed during the first six months of their lives as recommended by WHO (Table 7). There are a number of benefits of early breastfeeding. Colostrum is rich in protective factors and early initiation of breastfeeding ensures that the infant receives colostrum. Studies have shown that pre-lacteal feeding increases the risk of partial breastfeeding during the first 6 months which again has been associated with stunting[44] [12]. Better educated mothers are more likely to offer better caring and feeding practices for their children and would also be more likely to ensure that their children receive skilled health care [36]. This survey showed a significant relationship between women who did exclusively breastfeed their child during the first six months and the mother´s educational level, but receiving educational information on how to feed their child was not significantly associated with exclusive breastfeeding (Table 15). Currently, 66,2% children (6-24months) are breastfed (Table 7).

Table 7: Prevalences of the reference child´s (6-24months of age) health status (N=207)

Child (6-24months old): Breastfed during the last 6 months? (yes/no)	Yes	47,8%
Child (6-24months old): Currently breastfeeding? (yes/no)	Yes	66,2%

Table 15: Cross table chi^2 test to test for a statistically significant relationship between shown independent factors

Relationships between groups *		Pearson Chi^2
Educational level of mother	Exclusively breastfed child during first 6 months	0,036*
Educational information received on how to feed child	Exclusively breastfed child during first 6 months	0,157

** Association between two variables is statistically significant if asymptotic significance (2-sided) < p=0.05*

If the child was not exclusively breastfed during the first 6 months (N=70, 33,8%), 27,55% of mothers gave porridge to feed their children. The porridge consisted mainly of sorghum, bananas, maize and soybeans and would be a suitable vehicle for vitamin A fortified micronutrient powder. The majority of 72,5% gave water, fruits and food that was also eaten by the other family members to their children if they were not exclusively breastfed.

A qualitative analyses from Burns et al. in South Kivu conducted focus group discussions, structured and in-depth interviews with women of reproductive age, mothers of children <2 years, and health workers in 2012 to characterize infant and young child feeding (IYCF) practices and barriers to optimal child feeding[45]. The main barriers found, were the high work burden, milk insufficiency, lack of education and poverty. The high work burden seems to apply on this survey population as well, because 92% of women take care of the crops, 62,8% of women had help from their husbands and women had 2,7 times more crops to take care of than their husbands. 39,6 % of women and 24,2% of men take care of animals owned by the HH. These factors may indicates a lack of time for adequate child feeding. Burns et al. found also that women either tend to harvest the crops they cultivated or gather food from fields on a daily basis. The women also reported frequently to leave their children often for hours in the care of nannies, neighbours, or family members who commonly offered porridge to soothe the child when crying, as a reason for early introduction of complementary foods[45]. To take the child to the fields or returning from the field every few hours could be a strategy for exclusive breastfeeding, but women were concerned about factors such as distance to the field, conditions in the field, and the load the women have to carry. Milk insufficiency were explained by not eating well or not eating all day apart from some water and a piece of cassava[45]. 62,3% of the survey children between 5-33 months received the same food as the other HH members. The other 36,6% fed their children mainly porridge and bananas. Other reasons for not breastfeeding found by Burns et al. were the misconception that infants need water in addition to breast milk and that breastfeeding while pregnant would negatively impact the health of the child. This seems also to apply for this survey population, because 65% of pregnant mothers are currently not breastfeeding. Mothers also claimed to not know how to enrich children's meals as a barrier to improving complementary feeding. Many mothers reported not knowing they could add palm oil, avocados, bananas, mangos, mashed beans, and pounded peanuts to porridge. However, they expressed strong interest in learning how to prepare a variety of porridges and snack foods for the children[45]. These findings may indicate insufficient education for the mothers on how to feed their children, and also a guidance on how to improve education for mothers of infants. More opportunities to generate income, labour-saving technology could reduce the time mothers spend working in the fields, allowing them to spend more time caring for their children. It would also reduce the need to sell all crops and livestock rather than consume them in the household, which would increase access to greater quantities of diverse foods.

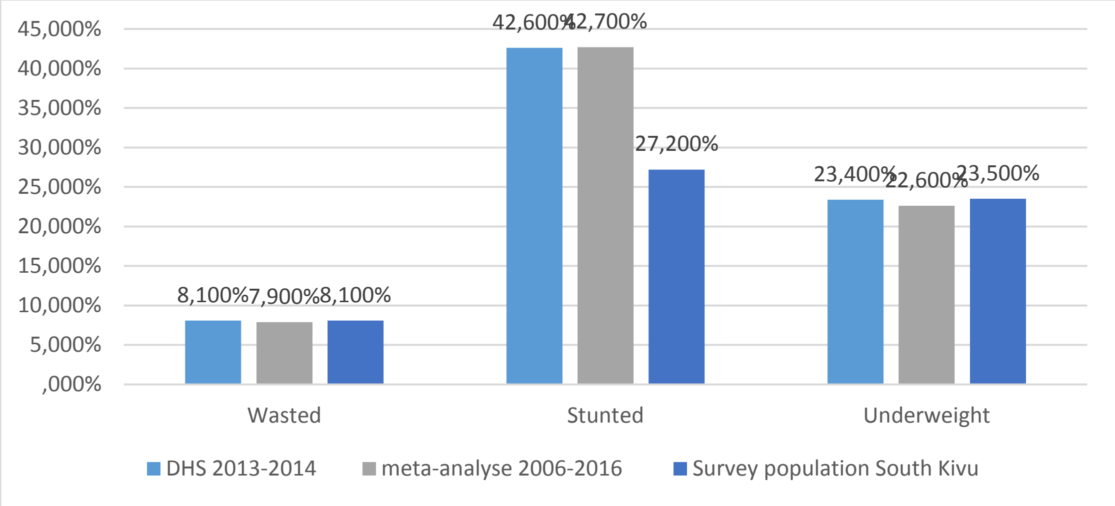
4.1.2 Anthropometric results

The anthropometric indices wasting (WHZ) indicating acute malnourishment, stunting (HAZ) indicating chronic malnourishment and underweight (WAZ) as a composite index of both, are important factors to evaluate the nutritional status of the survey infants 5-33 months of age. Figure 4 presents them individually with the distribution of the 3 groups that describe how nourished the children were. 43,5% of the survey children are not well-nourished (Figure 4), 27,2% are stunted, 23,5% are underweight and 8,1% are wasted (Figure 3). Figure 5 shows that 7,7% of stunted, 8,7% of underweight and 2,4% of wasted children were classified as severely malnourished. The majority of all children do not suffer from oedema (95,2%), bad skin condition (86%) nor have bad hair condition (80,7%); 9,2 % (N=207) of children are overall severely malnourished (children with oedema are included) and 43,5% of all children are either mildly/moderately or severely malnourished (Figure 4). This does not significantly vary across the territories (Table 15). Compared to the data of the Demographic and Health Survey of DRC 2013-14 and a meta-analyses from 2016, the prevalence of wasting and underweight does not differ but stunting in South Kivu seems deceptively less severe compared to DRC (figure 3)[46]. However, the Health Survey of DRC 2013-14 found also a prevalence of stunting in South Kivu of 53% (<5 year old children) and also that stunting is higher in rural areas than in urban areas (47% versus 33%) [3]. The majority of the poor people reside in the rural areas and lack access to basic health services. The causes of poverty are related to harmful economic systems, conflict, environmental factors such as drought and climate change, and population growth [44].

The reason for the big differences in the prevalence of stunting (Figure 3) can be due to the sample sizes. The meta-analyses from 2016 had a sample size of 9030 <5 year old children from DRC, and the Health Survey had 18827 children from DRC. This survey dealt with a rather small sample size of 207 participants.

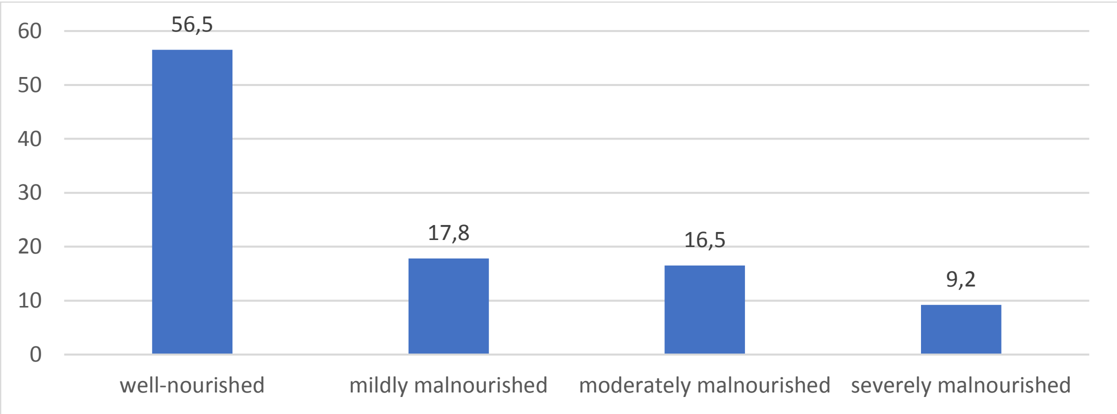
Surprisingly, no statistically significant relationship was found between stunting and wasting and whether the child was exclusively breastfed during the first 6 month, nor if the mother received any information about how to feed the child, nor the educational level of the mother (Table 15). Some studies found that children whose mother received any education are estimated to be 0.85 times less likely to be stunted and 0.73 times less likely to be wasted [36 44].

Figure 3: Prevalence of wasting, stunting and underweight of pre-school age children



DHS: Democratic and Health Survey of DRC 2013-2014

Figure 4: Prevalence of nourishment estimated by z-scores of children 6-24months of age (N=207) in South Kivu (Survey)



Well-nourished= all 3 z-scores >= -2
Severely malnourished= all 3 z-scores < -2 or
Moderately malnourished= 2 von 3 z-scores < -2
Marginally malnourished= 1 von 3 z-scores < -2

Figure 5: Nourishment of children 6-24months old in the groups of wasting, underweight and stunting (South Kivu Survey)

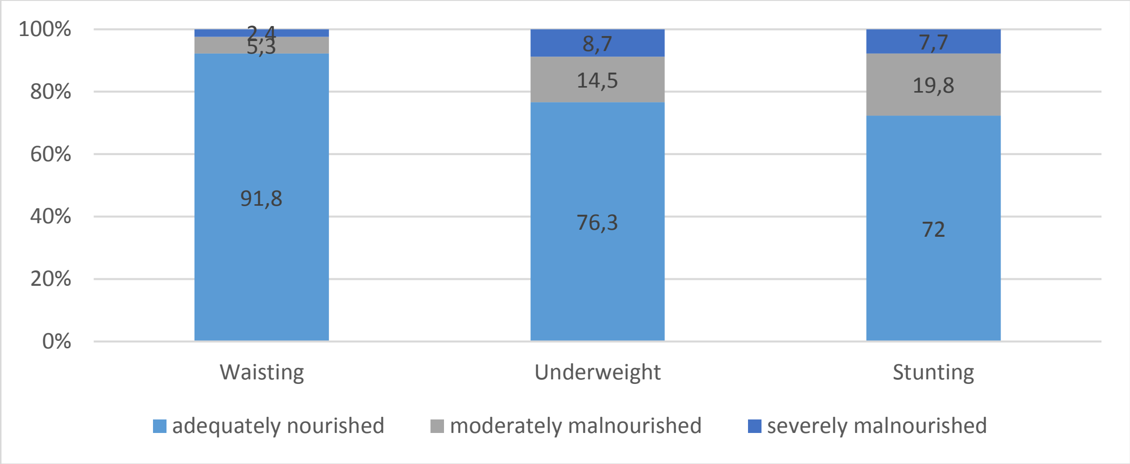


Table 15: Cross table chi^2 test to test for a statistically significant relationship between shown independent factors

Relationships between groups *		Pearson Chi^2
Exclusively breastfed child during first 6 months	Classification of stunting, underweight and wasting	0,950
Classification of stunting, underweight and wasting	Territories Kabare and Walungu	0,234

** Association between two variables is statistically significant if asymptotic significance (2-sided) < p=0.05*

Child stunting is widespread in the DRC and according to several publications the prevalence increases [25 44]. A study by Kismul et al. has identified modifiable factors determining high prevalence of stunting in the DRC[44]. South Kivu is one of the provinces with the highest prevalence of child stunting between 2013 and 2014 in DRC. The reasons for that are diverse. Manufactured goods including food items are sold at increasingly higher prices while cash cropping (a cash crop is an agricultural crop which is grown for sale to return a profit) is hard to develop. The land in South Kivu (affected by war) is fertile, but shortage of land and landlessness are problems closely related to food insecurity and chronic malnutrition. Kasai is another province in DRC with higher odds of stunting. The major livelihood in the province is artisanal mining, especially diamond mining. During the last 15 years, the diamond sector has been influenced by declining international markets. In addition, people tend to neglect food production and the province has to import much of its food. Several provinces with high odds of stunting face problems due to influx of internal as well as refugees from neighbouring countries.

This study also showed that the children living in the poorest household had higher odds of being stunted and the largest proportion of children with stunting lived in rural households[44]. Kismul et al. also revealed that about one fourth of mothers were teenagers at the time of their recent delivery and that children who had mothers whose age was above 20 years at delivery were less likely to suffer from stunting than children with teenage mothers[44]. Such results were not found in the South Kivu Survey, because the youngest mother was 18 years old and only 4,4% of all mothers were younger than 20 years. Also, there was no information about how old the mother was at her first pregnancy. Nevertheless, it should be said that early child birth represents a health risk both for mothers and children and has negative consequences for the growth of the child. During maternal growth there might be a competition of nutrients between the mother and the foetus and this competition might result in early childhood undernutrition and also increase negative implications of maternal malnutrition[47] [12]. What was also interesting in the study of Kismul et al. was that the prevalence of stunting increases further after the age of 2 years. This finding highlights the important relationship between stunting and inappropriate diet also at the age above 2 years characterised by monotony and little variety. To reduce stunting nutrition policies and programmes prioritizing food security, improving agricultural productivity and implementing contingency actions in the face of climate change are urgently needed. Literature has also shown that households with sufficient land, enough labour and access to social services could ensure that their children stayed well-nourished. Households with well-nourished children also benefited from taking part in inter-household cooperation[48]. Such social networks could enhance mother´s access to health advice and support. Therefore, it is important that nutritional programmes involve institutions for inter-household cooperation to further improve food security and nutritional outcomes.

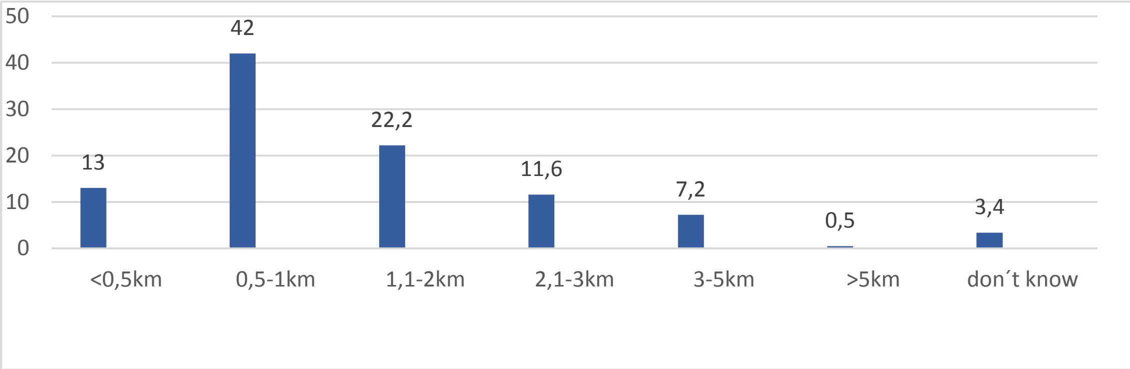
4.1.3. Care-seeking behaviour

It is known that sufficient vitamin A intake is important for the immune system and a healthy visual cycle in the retina of the eye. VAD can significantly increases the risk of severe illness, and even death, from common childhood infections such as diarrhoeal disease and measles[6]. Therefore, it is important to look at care-seeking behaviour of the mothers in case of health problems of their infants to detect health problems early enough. It is important for the mothers to get an understanding of the influences on care-seeking behaviour, because it can be critical for the success of existing and future health interventions and continued improvement of child health. Several studies conducted in Africa with the aim to learn about care-seeking behaviour show that women struggle with a number of barriers when it comes to treating their children. The most frequently mentioned dynamics noted as influencing care-seeking strategies seem to be diverse. For example lack of knowledge about availability of curative services, mistrust in biomedical and government providers, fear of evil eye, social stigma, perceived financial barrier, perceived young infant fragility, an elder's contrary advice, distance, husband's refusal, fear of injection and belief in recovery without medicine [49] [50] [51]. These results highlight the need for understanding the social factors for planning intervention programs to promote care-seeking behaviour and therefore overall health of child and mother.

In this survey population the health centre seems to be the address of choice for most households concerning treatment against sickness (information on particular symptoms was not obtained by the questionnaire) and information about how to feed children, because 64,3% received educational information on how to feed their child from the health centre, 11,5% from either community health workers/mother in law/radio/NGOs and 22,7% did not receive any information. The reason why almost a quarter of the survey population did not receive any information was not given.

68,6% the children and 48,3% of mothers were sick during the last one month. 85% of the mothers (N=100) and 62,8% (N=142) children who were sick received treatment. As already mentioned, there was no information on how severely sick the child or the mother was. 13% of the survey HH have <=0,5km, 42% have 0,5-1km and 22,2% have 1,1-2km to the next health centre (Figure 7).

Figure 1: Distances to nearest health centre in kilometre (N=207)

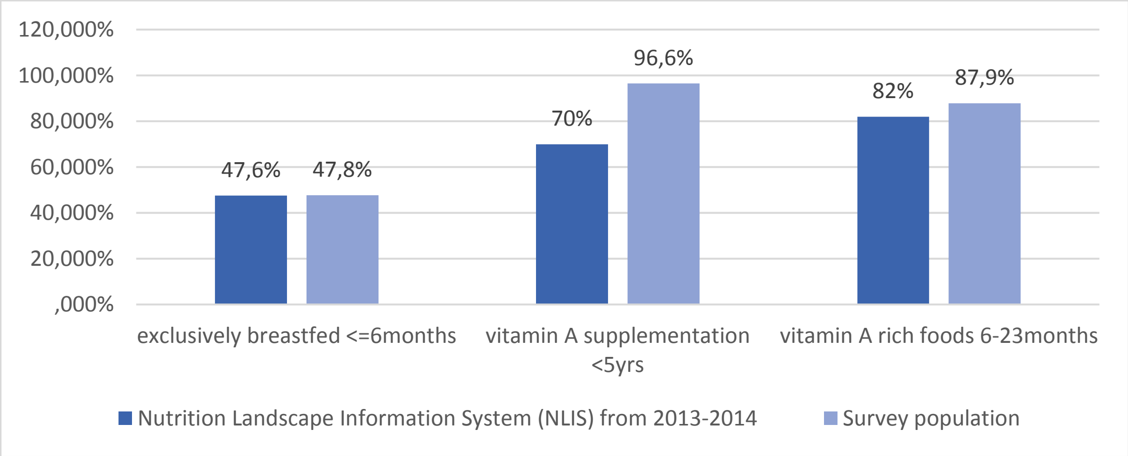


These results did not significantly associate with whether the child nor the mother received treatment in case they were sick. There was also no significant relationship found between the estimated monthly total off-farm income and whether child and mother received treatment in case of sickness. If the child needs treatment 36,7% of HH receive treatment from the health centre, 17,9% from the shop/chemist and 8,7% from either hospital/traditional medication or other sources. 36,7% did not give information about where they receive treatment if the child is sick. 48,3% (N=207)) of all mothers were sick in the last one months, 41% of them received their treatment from the health centre, 32% bought their drugs at the shop/chemist and 12% from either hospital/traditional medicine/or other not defined sources. And 15% of mothers did not give information about where they received the treatment from as they were sick. Additionally, it should be mentioned that 65,7% of all mothers have a healthy BMI between 18,5m/m2 – 24,9kg/m2, while 20,7% are overweight or obese and only 5,3% are underweight.

71% (N=207) of all mothers had no formal education or did not complete primary education.

Figure 8 below compares the prevalence of vitamin A supplementation, exclusive breastfeeding and consumption of vitamin A rich foods between the report of the Nutrition Landscape Information System (NLIS) from 2013-2014 and the survey population (Figure 8). The majority of the survey children (96,6%) 5-33months of age, did receive vitamin A supplementation and were immunized. However, efficacy trials since 1994 have in most cases not confirmed a mortality impact of vitamin A capsules and high-dose VA 6-monthly does not reduce prevalence of the deficiency itself, estimated by low serum retinol, but frequent intakes of vitamin A in physiological doses seem to be highly effective in increasing serum retinol [37]. Additionally it should be mentioned that vitamin A supplementation tends to entertain dependency and to convey the idea that VA deficiency is a medical problem, not a food and nutrition problem, which it is.

Figure 2: Prevalence of breastfeeding, vitamin A supplementation and consumption of vitamin A rich foods between the survey population (South Kivu Survey) and the report of NLIS



DRC government agency PRONAUT (Programme Nationale de Nutrition) takes a lead in implementing the nutrition policy. Examples of key areas are promoting early initiation of breastfeeding, exclusive breastfeeding during the first 6 months, introduction of complementary feeding at 6 months, continued breast- feeding up to the age of 2 years as well as addressing micronutrient deficiencies [52]. What the policy document does not directly deal with, is the problem of early age at delivery and short birth intervals. Furthermore it should be pointed out the importance of policy implementation attending to the issue of VAD and the within-country variability in stunting seen in the study of Kismul et al.

4.2. Vitamin A intake and consumption patterns

Preformed vitamin A is found almost exclusively in animal products, such as milk and dairy products, glandular meats, liver and fish liver oils (especially) and egg yolk. Pro-vitamin A carotenoids are found in green leafy vegetables, yellow vegetables (e.g., pumpkins, squash, and carrots), and yellow and orange non-citrus fruits (e.g., mangoes, papaya). Red palm oil is rich in pro-vitamin A as well [53].

Table 8: Food and supplemental vitamin A sources

Food and Supplemental Sources High in Vitamin A[8]
Preformed vitamin A in foods
Liver Fish liver oils dairy products: butter, cheese, milk fat, other dairy products Egg yolk
Pro-vitamin A carotenoids in plant foods
dark-green leafy vegetables deeply coloured yellow and orange vegetables and fruit
Supplemental vitamin A
preformed retinyl acetate or palmitate b-carotene in some multivitamins b-carotene

Foods containing pro-vitamin A carotenoids tend to be less biologically available but more affordable than animal products. It is mainly for this reason that carotenoids provide most of the vitamin A activity in the diets of economically deprived populations like in Africa [7]. According to the 24h-Recall of this survey population, 87,9 % of all (N=207) reference children (5-33months) and 90,8% of all mothers (N=207) consumed vitamin A rich foods in the last 24 hours (Table 9).

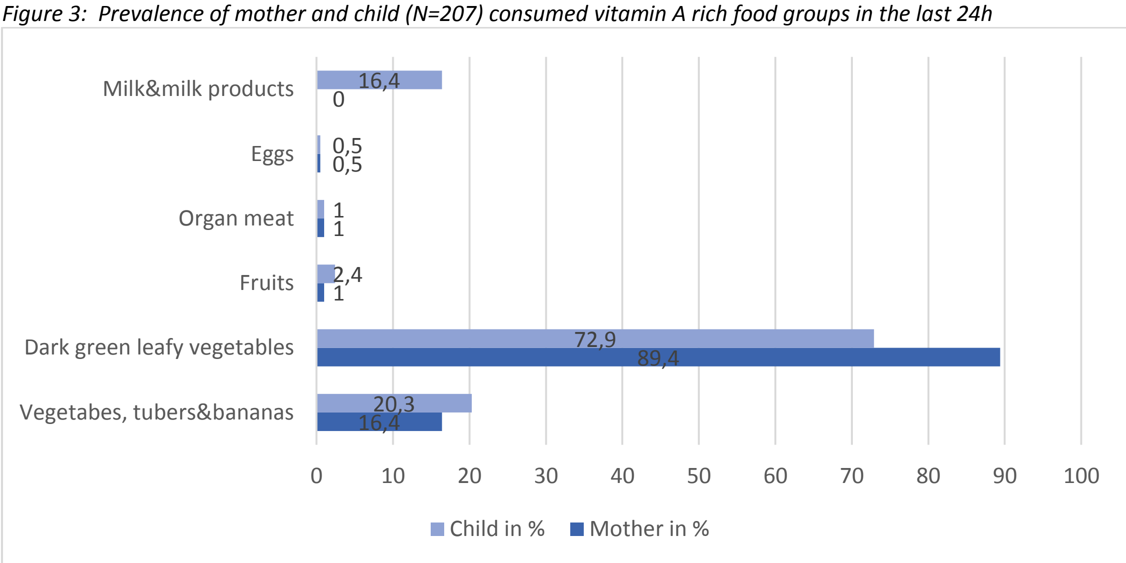
65,4% of the ingredients (except fats & oils, sweets & sugars and condiments & spices) consumed the previous day by the HH were bought at the market/shop and 31,3% of the ingredients were from the farm. Only 4% gathered/ hunted food, received food as a gift or got food from food aid (Table 10).

Table 10: Main source of all ingredients (except fats & oils, sweets & sugars and condiments & spices) consumed in the last 24h of mother and child (N=207)

	Farm %	Market/ shop %	Gift %	Food aid %	Gathering/ hunting %
Mother	30,9	65,8	2,4	0,8	0,07
Child	31,7	64,8	3,4	1,7	0,08
Sum	31,2	65,4	2,8	1,2	0,08

In context of this survey, no blood test on vitamin A was performed. Therefore it can´t be said whether the vitamin A intake of this study population is sufficient to prevent VAD, but looking at the current data in DRC (Introduction) the vitamin A intake seems overall insufficient. The main source of pro-vitamin A in the last 24 h appears to be dark green leafy vegetables. Since pro-vitamin A is less biologically available, it is necessary to look at VA-sources from animal products. Vitamin A from animal sources (milk and dairy, eggs, organ meat) were not consumed by the majority of mothers and reference children (Figure 8). A cross-sectional study with 207 lactating women in 2001 conducted in Zimbabwe found that 40% of the women had vitamin A deficiency (SR < 20 µg/dl) and 76% had low liver stores of vitamin A (RDR > 20%), while dark green leafy vegetables were the main sources of vitamin A[54].

Figure 3: Prevalence of mother and child (N=207) consumed vitamin A rich food groups in the last 24h

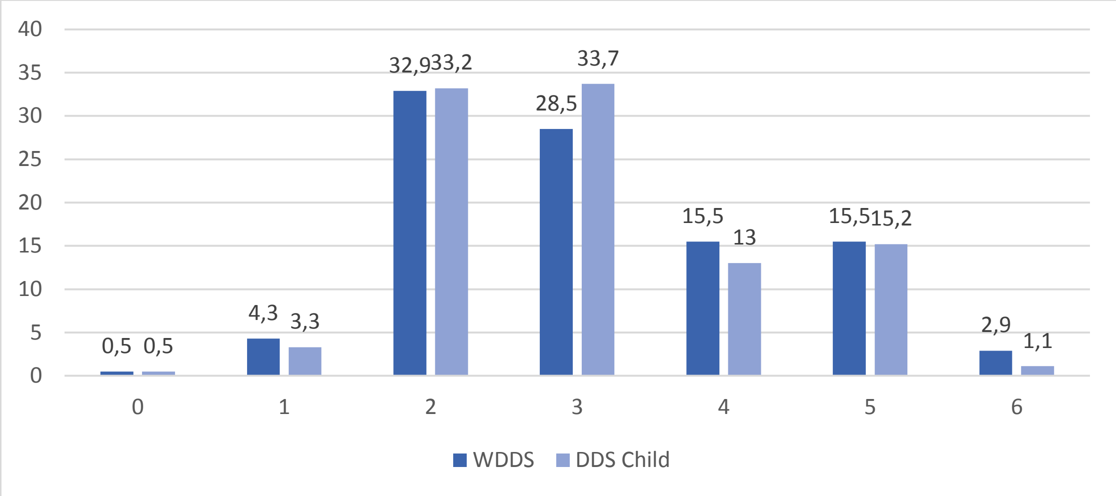


25,1% of mothers and 21,7% of children had fish the previous day (Table 9). Unfortunately there was no information given on what kind of fish it was. White roots, tubers and bananas seem to be the food of choice for the majority of all women (92,8%) followed by dark green leafy vegetables (89,4%), legumes, nuts and seeds (50,7%) (Table 9). Most consumed foods of the children were white roots, tubers and bananas (77,3%), followed by dark green leafy vegetables (72,9%), legumes, nuts and seeds (49,8%) and cereals and grains (39,6%). It has to be mentioned that only 6,3% of the mothers had at that particular day described an unusual day because of visitors or because they felt sick, otherwise the previous day was as usual.

The Dietary Diversity Score for women (WDDS) with 9 food groups and for their children (DDS child) is shown in Figure 10 below. The average diversity of 33 percent of those women with the highest DDS (upper tercile of diversity) is 4. No women reached a DDS higher than 6 and 66% were below the established target DDS of 4. A paper by Martin-Prévela et al. found that women of reproductive age who consume at least 5 food groups are likely to have higher micronutrient adequacy than women who consume foods from less food groups. These women are also more likely to consume at least one animal-source food and either pulses or nuts/seeds and food items from two or more of the fruit/vegetable food groups[55]. Because these findings are based on the minimal dietary diversity for women of reproductive age (MDD-W[42]) that involve 10 food groups (other vegetables and fruits are split into 2 groups), it is not an ideal comparison to the calculated WDDS for this survey population. However, since the 9 food groups do not differ much from the food groups in Martin-Prévela et al.´s paper, it can provide guidance to interpret the findings of this survey population. However, only 18,4% of women consumed at least 5 different food groups the previous day, which may indicate a possible insufficient dietary diversity.

1/3 of mothers (37,7%) consumed only 2 or even less food groups in the last 24 hours (figure 10). These food groups are most likely “white roots, tubers & bananas” and “Dark green leafy vegetables”. The results on DDS look similar for the reference children. Only 1/3 of the children (29,3%) reach the establish cut-off point of 4 different food groups.

Figure 4: Dietary Diversity Score for women (WDDS) and children (DDS child**) of the South Kivu 24h Recall Questionnaire*



**WDDS with 9 food groups*
*** DDS child with 7 food groups*

Figure 5: The estimated total off-farm income per months per household of the survey population in South Kivu

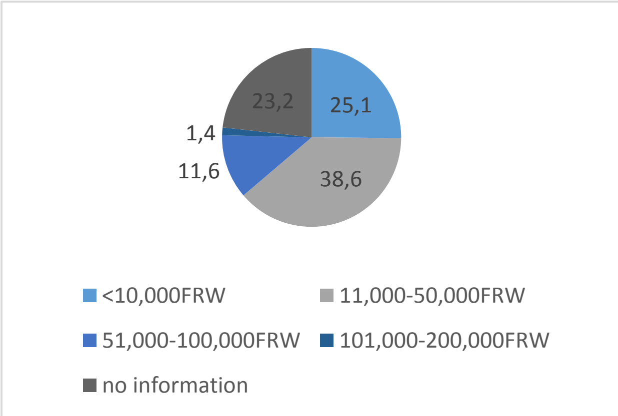


Figure 11 on the right shows the estimated monthly total off-farm income. 63,7% of the HH estimate to earn 50.000FRW or less per month, which equals 59,5 USD[56]. 13% estimate to earn 51.000FRW (61 USD[56]) or more. 23,2% were not able to estimate their monthly total off-farm income. The association between WDDS and the total off-farm income is not significant but close (p=0,079) to the established significance level of p=0,05 (Table 15). There is also no significant association between DDS and how nourished the child is. However, there is evidence that poverty does result in a less diverse diet; in a higher prevalence of stunting as discussed above, and eventually in higher prevalence of VAD and other micronutrient deficiencies[44].

Table 15: Cross table chi^2 test to test for a statistically significant relationship between shown independent factors

Relationships between groups *		Pearson Chi^2
WDDS	Total off-farm income	0,079
DDS child		0,232

DDS child	Classification of stunting, underweight and wasting	0,7

** Association between two variables is statistically significant if asymptotic significance (2-sided) < p=0.05*

Table 5: Prevalence of mother and child (N=207) consumed food groups in the last 24h

Food group	Mother Yes %	Child Yes %
Cereals & grains	15	39,6
White roots, tubers & bananas	92,8	77,3
Vitamin A rich vegetables, tubers & bananas	16,4	20,3
Dark green leafy vegetables	89,4	72,9
Other vegetables	28,5	23,2
Vitamin A rich fruits	1	2,4
Other fruits	1,4	2,4
Organ meat	1	1
Flesh meat	6,8	4,8
Eggs	0,5	0,5
Fish & sea food	25,1	21,7
Legumes, nuts & seeds	50,7	49,8
Milk & milk products	0	16,4
Oils & fats	89,9	75,4
Sweets & sugars	4,3	29
Condiments & spices	93,7	81,7
All vitamin A rich food groups together	90,8	87,9

To ensure consumption of a balanced diet that is adequate in vitamin A, food fortification has the dual advantage of being able to deliver nutrients to large segments of the population without requiring radical changes in food consumption patterns. On the other hand, it has also limitations to correct VAD if large numbers of the targeted population, either because of poverty or locality, have little or no access to fortified food, or when the level of VAD is too severe, or when infections increase the metabolic demand for the nutrient. 2006 WHO provided guidelines for food fortification to give information relating to the benefits, limitations, design, implementation, monitoring, evaluation, cost–benefit and regulation of food fortification, particularly in developing countries[7]. Suitable vitamin A–fortified foods, although limited, include sugar, cereal flours, edible oils and margarine (Table 12). 89,9% of mothers and 75,4% of children consumed oils and fats the previous day, but it cannot be said whether they were vitamin A rich fats such as red palm oil. Oils and fats appear to be a good vehicle for vitamin A fortification, since the majority of the HH in South Kivu consume it daily. There was no information given whether the HH consume any fortified foods. Margarines and oils are the ideal foods for vitamin A fortifications according to WHO, because the oil-soluble form of the vitamin is the cheapest available, and the oil protects the vitamin A from oxidation during storage and so facilitates absorption of the vitamin. Food-based approaches to increase the intake of vitamin A in populations include dietary diversification, point-of-use fortification with micronutrient powders (as mentioned above for porridge) or mass fortification of staple foods with vitamin A. The main commercial forms of VA that are available for use as food fortification are retinyl acetate and retinyl palmitates, along with pro-vitamin A (β-carotene)[7]. The use of airtight packaging for the vitamin A fortificant provides protection, because pure vitamin A and β-carotene in solution are unstable when exposed to ultraviolet light, oxygen or air. For example, the loss of vitamin A in sealed cans of oil is minimal, but losses from fortified cereals, fortified sugar or oil can be as high as 40%, depending on ambient conditions and storage times. Vitamin A loss can be 60% when the oil is reused several times for frying. It is estimated that about 90% of fortificated vitamin A will usually be absorbed[7]. Milk powder is a suitable vitamin A fortificant in this survey population as well. There was no information found whether there was a trial on these food vehicles in DRC and whether it was successful or not.

A study with the objective to assess the impact on serum retinol of adding red palm oil to school lunch in two test zones of Burkina Faso, found that it is highly effective in the reduction of VAD as a food supplement [53]. A systematic review of 2016 conducted in Ivory Coast, claims that fortification of vegetable oil clearly provides a meaningful additional amount of vitamin A. Noticing the estimates of average amount of vegetable oil consumed daily and adding fortification levels into the equation, the results of this review show that about half of women of reproductive age (WRA) cover 30% or more of the recommended nutrition intake for vitamin A, which is an important contribution to vitamin A intakes. And also for pre-school aged children (PSC) the proportion of those with an additional vitamin A intake of more than 20% of the recommended nutritional intake of vitamin A is about half of the population group of the review. Vitamin A-fortified oil has the potential to complement vitamin A intake in both WRA and PSC population groups, if one takes into consideration the additional vitamin A being consumed by younger children through breast milk [57].

Table 12: Vitamin A fortificants and their suitability as fortificants for specific food vehicles[7] and the ingredients of the 24h-Recall questionnaire of the South Kivu survey population

Food vehicle	Form of vitamin A	Stability	Ingredients 24h Recall*
Cereal flours	Retinyl acetate or retinyl palmitate (dry stabilized forms)	Fair	"Dry maize (grains/flour)"
Fats and oils	β-carotene and retinyl acetate or retinyl palmitate (oil-soluble)	Good	"Fats & oils/margarine"
Sugar	Retinyl palmitate (water dispersible forms)	Fair	"Sugar"
Milk powder	Retinyl acetate or palmitate (dry water dispersible forms)	Good	"Milk"
Liquid milk	Retinyl acetate (preferred) or palmitate (oily form, emulsified)	Good/fair depending on packaging	"Milk"
Infant formula	Retinyl palmitate (water dispersible beadlets)	Good	-
Spreads	Retinyl acetate or palmitate (oily form)	Good	-

** Ingredient options displayed in the 24h Recall questionnaire of the South Kivu survey population (Annex questionnaire)*

There are concerns about the routine consumption of large amounts of vitamin A over a period of time that can result in a variety of toxic symptoms including liver damage, bone abnormalities and joint pain, alopecia, headaches, vomiting and skin desquamation. However, β-Carotene and other pro-vitamin A carotenoids are less of a concern in terms of potential toxicity, not being active forms of the vitamin and because at high doses they are absorbed less efficiently. A recent review has indicated that the risk of excessive vitamin A consumption from fortified foods in women and young children is likely to be negligible [58 59]. To choose an ideal vehicle for VA fortification it is necessary to assess dietary patterns in detail. Table 12 displays possible food vehicles for vitamin A fortification that were displayed in the South Kivu questionnaire, meaning that there are several options of food vehicles available.

Agrobiodiversity of the survey population

Agriculture is primarily about using natural resources to feed people. By building on local cultures, protecting and strengthening livelihoods and ensuring good nutrition and health, we can manage a sustainable agricultural development.

Maize (87%), Cassava (76%), and beans (47%) were the crops of choice of all households in the survey population, but there was no further information given about the type. 2,9% of all HH did not have any species grown, 22,2% had on one land, 45,4% had on two lands, 24,2% had on three lands and 5,3% had on four lands at least one species grown. Pro-vitamin A rich crops were rarely grown. Only 5,8% (N=207) grow pumpkins, 2,4% grow mangoes and 0,5% grow papayas. 42% of HH have grown wild species for food. Sweet potatoes were grown by 26% HH. Mushrooms (19,3%) and wild rats (6,8%) were most common amongst these HH. Both rats and mushrooms provided only a minor contribution to the HH consumption and mainly no contribution to the HH income. These fruits, mushrooms and rats have the potential to help diversify every diet. With proper selection of fruit tree species, HH can have different kinds of fruit all year round. Once fruit trees are established, very little labor is required to maintain them and they continue to produce for many years. They will produce food even during difficult times when other garden produce may be hard to obtain. Fruit trees can also provide other benefits that include lumber, poles, medicine, income, shade, firewood, ornamental value, soil improvement, reforestation and protection of the environment. One reason for not planting trees was the discouraging fact that many fruit trees take 7-10 years before they start to produce[60]. Fruits and nuts, when eaten in the right amounts and combinations, are capable of providing all the necessary nutrition that the body needs, including protein and vitamins. An all-around great fruit tree that has become very popular in Central Africa is jackfruit. This India native has sweet tasty flesh and an edible nut, so it fits into all three of the nutrition food groups: protein; vitamins and minerals; and carbohydrates and fats[60].

Several papers conclude that the implementation of biofortified foods are highly effective. A review by Tanumihardjo et. al. including case studies of biofortification strategies used for sweet potato in Uganda and orange maize in Zambia has shown a promising improvement of vitamin A status. It has shown while ß-carotene intakes will obviously increase with orange-fleshed sweet potato (OFSP) consumption, a variety of factors influence ß-carotene's bioavailability and bioconversion to retinol (vitamin A). Therefore, if biofortified crops are used as a nutrition intervention to improve status, efficacy and effectiveness studies should be performed before the release of crops used for food preparation. In a subset of the children aged 0.5–3 years, OFSP contributed 53% of total pro-vitamin A intake, and this was positively associated with serum retinol concentrations.

Also orange maize can improve vitamin A status when consumed as a staple food. In fact, nonparametric analysis showed that consumption of biofortified maize improved total body vitamin A stores than the group that consumed the white maize[61 16]. Briefly, serum retinol concentrations are homeostatically controlled over a wide range of liver reserves; therefore, serum retinol does not always respond to interventions or reflect liver stores [8]. A typical amount of ß-carotene in orange-fleshed sweet potato varieties is 7 mg/100 g, thus providing 2.5 and 8 mg/day for children and women, respectively. Furthermore, OFSP consumption could be extended up to 9 months per year because sweet potato is harvested continuously from the field as needed. Currently, the selling capacity of orange maize is still low compared with white maize, due to consumer preference and an initial associated with yellow maize, which had negative connotations association with food aid and animal feed. Therefore consumers preferred white maize. Overall OFSP and orange maize in Africa seems to be a success story according to the review and also people are slowly beginning to accept the orange maize, especially when it is freshly harvested, owing to its sweet taste. Currently, both orange crops are available on the market[61].

Another randomized controlled trial showed that a daily consumption of biofortified yellow cassava or a supplementation of ß-carotene in Kenyan children showed both a modest increase in serum retinol concentration and a large increase in ß-carotene concentration [62]. In 2014 the annual meeting of ASN (American Society of Nutrition) about whether biofortified food crops improve vitamin A and iron status in women and children (8 human trials conducted), points out that biofortified food crops appear to have a positive impact on nutritional and functional health outcomes but additional implementation research will be needed to ensure the best possible beneficial impact of biofortification and make it sustainable in public health to implement it at large scale in the real world [63]. Harvest Plus has implemented biofortified orange cassava in DRC. The goal of Harvest Plus is that more than 1.2 million Congolese farming households will be growing biofortified crops by 2018. Therefore a report on whether this implementation had a positive effect on VAD in DRC can be expected after 2018.

Biofortificated crops seem to be an optimal choice for tackle VAD in terms of efficacy, but the actual challenge is to get producers and consumers to accept biofortified crops and increase their intake of the target nutrient. Which can be achieved by good seed systems, the development of markets and products, and demand creation. Since biofortification of cassava or sweet potato with ß-carotene result in a deep yellow or orange colour, they are unfortunately often rejected in favour of white or cream-fleshed types having little or no pro-vitamin A activity. Not only the colour but also the moist texture of biofortified crops are reasons for rejection[64]. On the contrary, a small study with 30 children and 30 caretakers from Kenya, found that not only both preferred pro-vitamin A rich cassava over white cassava because of its soft texture, sweet taste and attractive colour, but also that knowledge about pro-vitamin A rich cassava and it's relation to health as a predictor of 'Health behaviour identity'; the belief of the caretaker about having control to prepare cassava and activities like information sessions about pro-vitamin A rich cassava; and recommendations from health workers were the best predictors of intention to consume pro-vitamin A rich cassava [65]. These results indicate reference points to approach the acceptance of biofortified foods successfully.

4.3. Food security and hidden hunger

The term "hidden hunger" is synonymous with micronutrient deficiencies and accurately describes the invisible nature of the problem and the lack of evident symptoms of VAD or more deficiencies. Its pervasive nature holds significant individual, social, and economic consequences as well. 56,5% of all HH (N=207) of the survey population in South Kivu suffer either from moderate or severe hunger and 43,5% suffer from little or no hunger (Table 13). The household-hunger-score (HHS) is significantly associated with the estimated monthly total off-farm income (Table 15). Only 1,9% of the HH consume at least 3 meals per day (Table 13).

Table 15: Cross table chi^2 test to test for a statistically significant relationship between shown independent factors

Relationships between groups *		Pearson Chi^2
HH-Hunger Score	Estimated total off-farm income/month	0,000*

** Association between two variables is statistically significant if asymptotic significance (2-sided) < p=0.05*

To secure adequate food to meet the dietary requirements, HH have their own food production or purchase food [66]. Food production depends on a wide range of factors, including access to fertile land, availability of labour, appropriate seeds and tools, and climatic conditions. Factors affecting food purchases include household income and assets as well as food availability and price in local markets. In emergency situations, other factors may come into play like physical security and mobility, the integrity of markets and access to land[67]. In this survey, 2,9% of HH have no crop grown on their land and miss therefore the opportunity to produce food for consumption or sale.

Literature shows that food insecurity remains an essentially rural phenomenon, because the people producing food often do not make enough to feed their families due to the lack of adequate access to means of production (land, manure, tools), and rural communities are poorer and struggle to buy food[31]. Consequently, achieving agricultural development is a necessary condition for reducing food insecurity, but is not sufficient by itself. Although agricultural development alone is unable to eliminate hunger and malnutrition, it is an obligatory, essential and priority element. To secure access to land by controlling and minimising agricultural risks; by diversifying agricultural activity systems and sources of income (encouraging rural "multiactivity"); or improving the structure and regulation of markets can promote food security[68 69] .

Research has shown that most rural households buy at least some of their food supplies from the market, particularly during years when the harvest is poor and prices are thus higher. Rural incomes are low and irregular, and this factor combines with the instability of food markets, particularly in areas with shortages, to increase the concentration of food insecurity in rural areas. 63,7% of the survey population estimate to earn 50,000FRW or less per month (Table 13).

Table 13: Prevalences of shown factors for every household of the survey population in South Kivu (N=207)

HH-hunger score	Little or no hunger	43,5%
	Moderate hunger	46,4%
	Severe hunger	10,1%
Average number of meals per day in HH (past 4 weeks)	One meal/day	21,3%
	Two meals/day	76,8%
	Three meals/day	1,9%
Monthly total off-farm income	<10.000 FRW	25,1%
	11.000-50.000 FRW	38,6%
	51.000-100.000 FRW	11,6%
	101.000-200.000 FRW	1,4%

HH that cannot afford nutritious foods due to low income are mostly linked with the insufficient diet and disease that leads to undernourishment. Such households usually spend the bulk of their total income on food. Any health problem that requires spending part of the meagre family income can further perpetuate food insecurity. Food insecurity varies according to the season. In rural areas, the longer the period since harvest time, the more people's food stocks diminish and prices rise. The instability of prices throughout the year is exacerbated by the contained nature of local markets and the fact that national markets are restricted and relatively isolated from regional markets. This seasonality has a particularly strong impact on households that are highly dependent on the market for their food[14]. Also this study shows that mother and child get their food eaten the previous day mainly from the markets (65,4%) and from the farm (31,2%). It wasn´t said whether the crops they plant are used as a food or if it is meant for sale. This information would give an insight in their total income (not only total off-farm income as conducted in this survey) and also in their food consumption. It could also give an insight about the balance between harvested food that was consumed or sold and therefore an insight about the potential of use of the harvest and food security of each HH. Study from Ethiopia between 2010-2011 conducted by Sibhatu et al. shows that cash income from farming and cash income from off-farm economic activities are both almost equally important for food purchases, with some seasonal variation[70].

Food insecurity has a particularly strong impact on young children and their mothers; within families where the best food is sometimes kept for the men. Young children along with pregnant and breastfeeding women are more liable to suffer from nutritional deficiencies[71]. In regards 44% of all HH assessed in this survey borrow food from friends or relatives, 17,9% reduce the quantity of food, 13,5% work for food, 6,3% reduce number of meals, 12,1% choose to do nothing and stay hungry and 1,4 % rely on food aid (Table 13). The first priority family member if there was not enough food to eat in the HH were either children <5years of age (44%) or they share equally (37,7%) (Table 13).

Table 13: Prevalences of shown factors for every household of the survey population in South Kivu (N=207)

If not enough food, what do you do?	Do nothing/stay hungry	12,1%
	Rely on food aid	1,4%
	Borrow from relatives/friends	44%
	Work for food/money	13,5%
	Reduce the number of meals	6,3%
	Reduce the quantity of food prepared	17,9%
	Not applicable	4,8%
If not enough food, who is first priority member?	Young children <5years	44%
	Adult men in general	2,4%
	HHH	13,5%
	Elderly men	1%
	Elderly women	1%
	We share equally	37,7%
	Not applicable	0,5%

Currently there is a project called “Agroforestry for food security and sustainable development in the Gungu territory”. Its aim is to improve security and reduce poverty in the Gungu territory of the DR Congo between January 2013- December 2017 [69]. There is no update available at this moment.

Looking at the potential of the HH to secure food, the HH have access to land and food markets, but it could not be definitely said whether the land is fertile (1/3 of HH claimed their harvest was worse compared to last season), if the tools used are appropriate and whether the climatic conditions were good and well predicted. There was also no information whether the foods on the markets were affordable and who of the HH goes to buy food. This information would give a better insight of the potential to secure food for each HH. If food security is defined as “…access to enough food for an active healthy life” livestock can make a major contribution. 62,3% of all HH own one or more kinds of animals. Most of them provide only a minor contribution to food consumption and income. The most common animals owned by the HH were guinea pigs (37,2% own on average 6 guinea pigs) and hens (19,8% own on average 2,5 hens) (Figure 12). Guinea pigs are mainly used as food (68%) and hens mainly as food (37%) and for sale (44%). These animals are also used as fertilizers (Table 14). However, according to the HH both animals contribute little to overall HH consumption and income (Table 14).

Figure 12: Prevalence of households (N=207) owning shown animal species

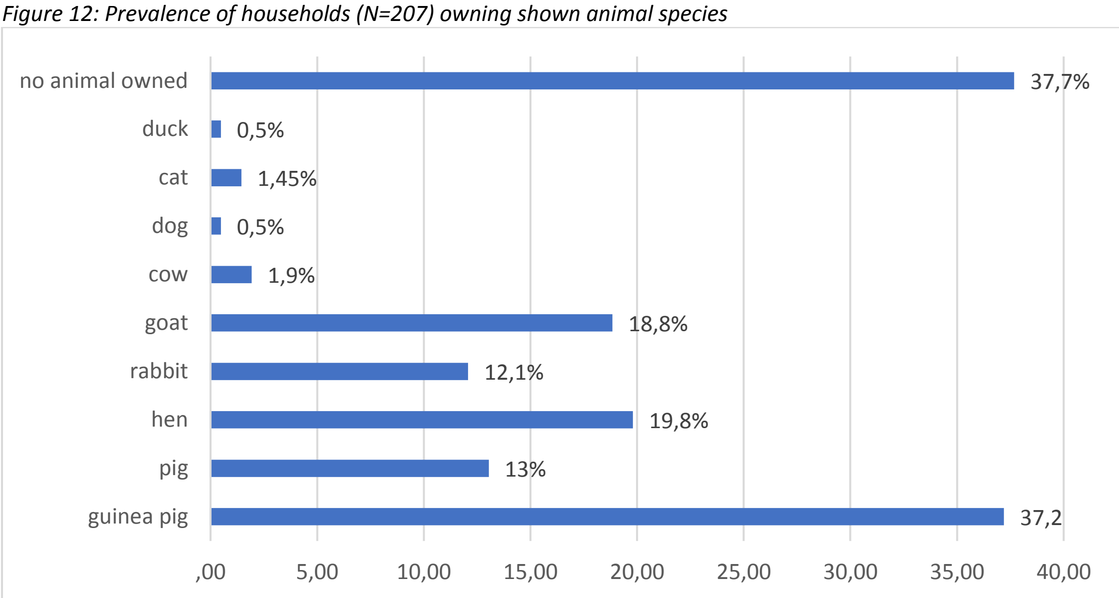


Table 14: Usage and contribution of animals owned by households (N=207) to income and consumption

	Guinea pig	Hen
Use of animal*		
Food%	67,5	36,6
Fertilizer%	40,3	26,8
Sale%	3,9	43,9
Contribution of animal species to food consumption*		
major	11,7	17,1
medium	16,9	17,2
minor	59,7	48,8
none	10,4	12,2
Contribution of animal species to income*		
major	7,8	9,8
medium	1,3	7,3
minor	32,5	53,7
none	42,9	29,3

** evaluated from the number of households that own the named animal species*

A diet that lacks protein can lead to reduced retinol binding protein in human due to an overall protein deficiency. The value of dietary animal protein is in excess of its proportion in diets because it contains essential amino acids that are deficient in cereals. Eating even a small amount of animal products corrects amino acid deficiencies in cereal-based human diets, permitting more of the total protein to be utilized because animal proteins are more digestible and metabolized more efficiently than plant proteins.

However based on this survey, an improvement of animal production can be recommended, since the interest of mini-livestock and small scale farming is not only to meet the needs for animal protein, but it could also show advantages in the socio-economic characteristics of its production and it could alleviate poverty. The study by Sibathu et al. shows that over 80% of the food diversity is purchased in the market, with farm cash income playing a larger role than off-farm cash income in rural Ethiopia[70]. Therefore, strengthening market access and thus opportunities to generate cash income should be a key element in strategies to improve diets and nutrition in the small-farm sector. Animal production can also provide income to buy food at the markets.

Animals constitute a sustainable alternative for meat production, for several reasons. First, they require little investment and are, for this reason, low-risk activities while generating steady income. This steady income they provide is especially valuable in contexts where financial services are lacking and where social and own economic pressure to spend the money available are high. Most of these species require less space than larger species and are thus accessible to poor households, including those that do not own any land [66].

Backyard poultry refers to low-input production systems, with a financial or social role rather than being a true income-generating activity. Poultry is then often part of a diversified livestock portfolio. Households in the Congo Basin generally practice the farming of indigenous chicken as a secondary activity. As shown in table 16 and figure 14, 19,8% of the survey HH own hens (on average 2,5 hens). Farming chickens provide meat, eggs (egg yolk is high in vitamin A) and could therefore contribute to food security. To achieve the required results, applied research, development and extension are made in pilot farms promoting appropriate technologies in the context of a comprehensive approach to animal productions incorporating animal nutrition, health, genetics and selection, environment and management [66]. Therefore a closer look on the options for animal production that HH have, to obtain enough protein in their diet is needed. Guinea pigs and hens seem to have the most potential in this survey population, since 57% of HH own at least one of them and use them as food, fertilizer and for sale.

5. Conclusion and recommendations

Vitamin A deficiency (VAD) remains a public health problem. Reasons for that are diverse and in order to find a solution, the issue needs to be operated on a multidimensional level to stop its vicious cycle.

WHO recommends high-dose vitamin A supplementations in infants and children 6-59 months of age in settings like DRC where vitamin A deficiency is a public health problem, meaning that the prevalence of night blindness is 1% or higher in children 24–59 months of age or where the prevalence of vitamin A deficiency (serum retinol 0.70 µmol/l or lower) is 20% or higher in infants and children 6–59 months of age.

It is difficult to attribute non-ocular symptoms specifically to VAD in the absence of biochemical measurements reflective of vitamin A status. Many countries have not been able to assess the true level of deficiency, because of technical and financial constraints, such as limited ability to transport and store biological samples or lack of laboratory facilities. Also the transparency and more detailed information of ongoing public health interventions in DRC seem inadequate and make it difficult to draw a big picture of what is currently going on. However, current data suggests that VAD is still a problem that has not yet been solved.

The fact that VAD is a result of many factors, suggests to look at it from different perspectives. There are many factors that influence vitamin A status, such as intake and its requirement. Concerning women of reproductive age and children, VAD occurs especially during the last trimester when demand by both the unborn child and the mother is highest, and also during lactation if the breastmilk is low in vitamin A. VAD-related blindness is most prevalent in children under 3 years of age due to high requirements for vitamin A to support early rapid growth, the transition from breast-feeding to dependence on other dietary sources of the vitamin, and increased frequency of respiratory and gastrointestinal infections.

The basis for lifelong health, vitamin A as a crucial component, begins in childhood. Promoting breastfeeding is the best way to protect babies from VAD, since breast milk is a natural source of vitamin A. Yet, only 66% of the children in the survey population of South Kivu have been exclusively breastfed during the first 6 months, and the fact that it did not significantly correlate with whether the mother was taught how to feed her child, indicates the necessity of improved teaching methods. Additionally, there is the big work load that mothers face on daily bases, which keeps mothers occupied most of the time during the day, struggling not only with breastfeeding their children, but also eating enough themselves. Not eating enough throughout the day results in insufficient breastmilk quality and quantity, too early complementary feeding and exhaustion of the mother.

Because breastfeeding is time-limited and the effect of vitamin A supplementation capsules lasts only 4-6 months, they are only initial steps towards ensuring better overall nutrition and not long-term solutions. Also, vitamin A supplementation tends to entertain dependency and to convey the idea that VA deficiency is a medical problem, not a food and nutrition problem, which it is. It has also shown that high-dose VA every 6 month does not reduce prevalence of the deficiency itself, estimated by low serum retinol, but frequent intakes of vitamin A in physiological doses seem to be highly effective in increasing serum retinol. At this point, food fortification takes over where supplementation leaves off. Porridge, mainly from sorghum and sugar was given to the child as additional food to breastfeeding and represents therefore a suitable vehicle for cost-effective micronutrient powder (MNPs) in South Kivu. Since oil was consumed by the majority of the survey population, and because several studies have shown that fortified red palm oil is a suitable vehicle for vitamin A, it can be considered as a potential fortificant in South Kivu.

Since maize and cassava were one of the most consumed foods in South Kivu, biofortified maize and cassava can be implemented long-term. Currently, an intervention of Harvest Plus implementing vitamin A rich cassava is taking place in DRC. The results are going to be presented after 2018.

Growing fruits and vegetables in home gardens complements dietary diversification and fortification and contributes to better lifelong health as well. Also promoting and supporting mini-livestock/small scale farming to improve protein intake (retinol binding protein), to alleviate poverty and for its social-economic advantages. Guinea pigs and hens, as commonly owned animals seem to have the highest potential in this survey population. Nevertheless, further investigations are needed to break down the possible and feasible options for rural and urban areas in DRC and whether such interventions meet acceptance and how to raise acceptance. Literature has shown insufficient compliance and mistrust of target populations, due to lack of transparency, given information and communication from health workers and other participants of the intervention programs. The target population believes in the benefits of the programs, but to gain community support, they need more detailed information for a better understanding of the importance of the intervention. Therefore, different or/and reconsidered approaches are needed to tackle VAD.

Conclusively, frequent intakes of vitamin A in physiological doses —e.g. through food-based approaches, including fortification, and through regular low-dose supplementation—have shown to be highly effective in increasing serum retinol and reducing vitamin A deficiency; therefore a policy shift is needed, based on consideration of current evidence. Also a prudent phase-over is needed towards increasing frequent regular intakes of VA at physiological levels, daily or weekly, replacing the high-dose periodic capsule distribution programmes. Also, directly engaging community members in a dialogue might be beneficial in terms of improving acceptability and overall access to health services and interventions. Along with that, novel ways of reducing the high out-of-pocket expenditure supporting poverty, should be explored as well.

The findings of this survey conclude that the problem VAD as such, cannot be solved by nutritional interventions alone. Approaches on how a stronger political commitment and a more appropriate level of investment in the effective control of vitamin A deficiency could make a large contribution towards the reduction of child mortality rates.

Since mothers have the main responsibility to take care of their children, relieving them from their work load and by that giving them more time to take care of their children is the most crucial step towards a better health behaviour. A less exhausted mother is more likely to be able to feed her child and herself, practices adequate care-seeking behaviour and develops a better health behaviour identity. To make these steps possible it is necessary to include topics into education such as time management, division of labour and the importance of local cooperations. Also resolving misconceptions about feeding practices should get more attention. By providing a contact person for open questions and detailed information about the background of every intervention, better knowledge, trust and self-efficacy can be promoted as well. Self-efficacy is important to decrease dependency of locals, and promote the capacity for self-help within the communities. Promotion of planting papayas, mangoes and pumpkins for home-gardening and holding small animals like guinea pigs and hens as a less time demanding mini-livestock is another effective way of generating cost-effective access to vitamin A rich foods. While focusing on these approaches, vitamin A supplementation represents an effective transitional solution in DRC.

Among the many challenges that DRC will need to face in the coming years, vitamin A deficiency is one that can be overcome. The need is urgent, and the solutions are known, effective, and affordable.

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7. Annex

7.1 Abstract (English)

Background

Vitamin A deficiency (VAD), showing itself in its ocular manifestations like xerophthalmia and night blindness mainly in mothers and children has been recognized as a public-health issue in DRC. VAD appears to be a multifactorial problem concerning economic constraints, sociocultural limitations, insufficient dietary intake, and poor absorption leading to depleted vitamin A stores in the body. This has been regarded as potential determinants of the prevalence of VAD in Democratic Republic of Congo (DRC). Several recent estimates confirmed higher morbidly and mortality rate among children and pregnant and non-pregnant women of childbearing age. Estimates on the potential benefits of vitamin A deficiency control are needed for policy and program advocacy.

Objective

Because the reason behind VAD is so diverse it is important to look at its multidimensional character. The prevalence of VAD decreased in the last decades, but still remains a public health issue. There are three general ways for improving vitamin A status: supplementation, fortification, and dietary diversification. These approaches have not solved the problem in African countries to the desired extent. The aim of this survey was to look into the life circumstances of the population in DRC and the programs that were carried out to identify the limitations of these programs and therefore the reason for the slow progress.

Methods

A cross-sectional study was carried out in South Kivu using a questionnaire to gain information about household characteristics, consumption patterns and agrobiodiversity of 207 care givers and their child <5yrs, and the results were compared with current DRC health reports. Further literature research about current programs

tackling VAD in DRC was carried out as well to answer the question why VAD remains a public health issue.

Results

96,6% of the reference children between 5-33 months did receive vitamin A supplementation. No blood samples were taken to examine the actual vitamin A status. The majority of children (87,9%) and mothers (90,8%) did consume food rich in pro-vitamin A (green leafy vegetables) in the last 24h, but almost no household consumed vitamin A rich foods from animal origin, although pre-formed retinol (vitamin A) from animal-sourced foods is better available for the body. 66% of mothers and 71% of children did not reach the established target dietary diversity score (WDDS and DDS) of 4. Only half (47,8%) of the mothers practised exclusively breastfeeding in the first 6 months of life as WHO recommends. The majority of mothers engage in time consuming labour. Education level was significantly associated with the feeding practice but education on how to feed their children was not. 43,5% of children are either mildly, moderately or severely malnourished. Stunting remains an issue in DRC with an approximate prevalence of 40% according to dietary and health survey (DHS 2013-2014) and 30% in the survey population of South Kivu. Oil, cassava, green leafy vegetables i.a. were the most consumed foods; cassava, maize and beans were the crops of choice in the survey households. More than the half of the survey households suffered from moderate or severe hunger in the previous 30 days. The hunger score was significantly associated with the estimated monthly total off-farm income. Only 1,9% of households consumed at least 3 meals a day. 85,5% of the households claim to have farming as a source of income.

Conclusion

An insufficient vitamin A intake leading to VAD is caused by many factors, i.e. such as poverty, limited access to markets and lands, neglect of food production, different nutrient requirement in different phases of life, early child birth, and low dietary diversity. According to research, food fortification of oil, point of use fortification of porridge or other meals, home-gardening and mini-livestock are effective ways to tackle VAD in DRC. Also biofortified cassava is likely to find acceptance in the survey population in South Kivu but also in DRC. Currently, Harvest Plus is implementing biofortified cassava and will provide an update on the effect. There are also political interventions against poverty needed to stop the vicious cycle of VAD. This survey suggests that the time-burden that women face have to be reduced and only nutritional interventions might not be enough to defeat VAD, since it treats the symptoms of VAD but does not eliminate all the roots, which are i.e. of socio-economical, financial and political nature.

7.2 Abstract (German)

Hintergrund

Vitamin A-Mangel (VAD) zeigt sich in Form von Xerophthalmie und Nachtblindheit hauptsächlich bei Mütter und Kinder und stellt ein Public Health- Problem in DRC dar. VAD ist ein multifaktorielles Problem, welches ökonomische und soziokulturelle Einschränkungen, unzureichende Nährstoffaufnahme und Absorption betrifft, welche zu leeren Vitamin A-Speichern im Körper führen. Diese Faktoren werden als potentielle Determinanten der VAD-Prävalenz angesehen. Einige Schätzungen haben eine höhere Morbidität und Mortalität unter Kindern, Schwangeren und Frauen im gebärfähigen Alter bestätigt. Für die Politik und Interessensvertretungen ist es notwendig das Potential von VAD-Kontrollen einzuschätzen.

Zielsetzung

Da die Ursache hinter VAD sehr vielfältig ist, ist es wichtig seinen multidimensionalen Charakter zu beachten. Die Prävalenz von VAD konnte in den letzten Dekaden gesenkt werden, trotzdem bleibt es ein Public Health- Problem. Es gibt 3 generelle Wege um den Vitamin A-Status zu verbessern: Vitamin A Supplementierung, Anreicherung und die Förderung einer abwechslungsreichen Ernährung. Diese Ansätze haben das Problem bisher in afrikanischen Ländern noch nicht zufriedenstellend gelöst. Das Ziel dieser Erhebung war es die Lebensumstände und die VAD Interventionen genauer zu betrachten, um die Grenzen und Herausforderungen der Programme zu identifizieren und so den Grund für den langsamen Fortschritt herauszufinden.

Methoden

Es wurde eine Querschnittsstudie in South Kivu durchgeführt durch die Verwendung eines Fragebogens, welcher auf Haushalts Charakteristika, Konsumverhalten und Agrobiodiversität von 207 Müttern mit ihrem <5 Jahre altem Kind. Die Ergebnisse wurden mit aktuellen Daten aus Gesundheitsberichten verglichen und es wurde nach weiterer Literatur gesucht bezüglich aktuellen Ernährungsinterventionen die auf eine Verbesserung des Vitamin A-Status in DRC abzielen, mit dem Ziel die Frage warum VAD immer noch ein Public Health- Problem ist zu beantworten.

Ergebnisse

96,6% der Referenzkinder zwischen 5-33 Monaten bekamen Vitamin A-Supplementation. Es wurden keine Blutproben genommen um den tatsächlichen Vitamin A-Status zu untersuchen. Der Großteil der Kinder (87,9%) und Mütter (90,8%) konsumierten Nahrungsmittel, welche reich an Provitamin A sind (fast ausschließlich grünes Blattgemüse) in den letzten 24 Stunden. Allerdings wurden kaum tierische Vitamin A- Quellen konsumiert, obwohl Vitamin A aus tierischen Quellen besser für den Körper verfügbar ist. 66% der Mütter und 71% der Kinder, haben nicht den etablierten Soll-Score 4 für diätische Vielfalt (WDDS und DDS) erreicht. Nur die Hälfte (47,8%) der Mütter haben, wie es die WHO empfiehlt, ihr Kind in den ersten 6 Lebensmonaten ausschließlich gestillt. Der Großteil der Mütter ist in zeitraubender Arbeit involviert. Das Bildungslevel der Mütter war statistisch signifikant assoziiert mit den Fütterungspraktiken der Mutter, aber es gab keinen statistischen Zusammenhang zwischen der Fütterungspraktik und ob die Mutter unterrichtet wurde bezüglich Fütterungspraktik. 43,5% der Kinder sind entweder mild, moderat oder schwer unterernährt. Stunting bleibt ein Problem in DRC mit einer ungefähren Prävalenz von 40% gemäß der Ernährungs- und Gesundheitserhebung zwischen 2013-2014 (DHS 2013-2014) und 30% Prävalenz aus dieser Erhebung in South Kivu. Öl, Cassava, grünes Blattgemüse waren die meistkonsumierten Lebensmittel; Cassava, Mais und Bohnen wurden am häufigsten von den Haushalten angebaut. Mehr als die Hälfte der Haushalte litten in den letzten 30 Tagen unter moderatem oder schwerem Hunger. Der Hunger-Score war statistisch signifikant assoziiert mit dem geschätzten monatlichen außerlandwirtschaftlichen Einkommen. Nur 1,9% der Haushalte konsumierten zumindest 3 Mahlzeiten am Tag und 85,5% gaben an, dass die Landwirtschaft eine Einkommensquelle darstellt.

Schlussfolgerung

Die Ursachen einer insuffizienten Vitamin A- Aufnahme, beziehungsweise von Vitamin A- Mangel, sind vielfältig. Beispiele dafür sind Armut, limitierter Zugriff auf Märkte und Anbauflächen, Vernachlässigung von Nahrungsproduktion, unterschiedlicher Nährstoffbedarf in unterschiedlichen Lebensphasen, Frühgeburten und niedrige Lebensmittelvielfalt. Nahrungsanreicherung von Öl, Gebrauchsanreicherung von Brei oder anderen Mahlzeiten, Heimgärtnerei und Kleinvieh, wären gemäß den Forschungsergebnissen effektive Lösungen um Vitamin A- Mangel in DRC sowie South Kivu zu bekämpfen. Auch Bioanreicherung von Cassava hat, laut aktueller Daten Potenzial Anklang in der Bevölkerung von South Kivu und in ganz DRC zu finden. Harvest Plus implementiert zurzeit bioangereicherte Cassava bis Ende 2018. Um den Teufelskreis von Vitamin A- Mangel zu stoppen, sind auch politische Interventionen gegen Armut notwendig. Der Zeitaufwand und die Arbeitslast mit denen Mütter täglich konfrontiert sind und die Kinderbetreuung negative beeinflussen, müssen reduziert werden. Ausschließlich ernährungsbezogene Interventionen sind möglicherweise nicht genug um Vitamin A- Mangel zu bekämpfen, da es häufig nur die Symptome bekämpft aber nicht die Wurzel des Problems, welche von sozioökonomischer, finanzieller und politischer Natur sind.

7.3 List of Abbreviations and Acronyms

ASN	American Society of Nutrition
BCMO1 (gen)	Beta-Carotene 15, 15′-Monooxygenase 1
BMI	Body Mass Index
CIAT	Centre for Tropical Agriculture
CGIAR	Consultative Group on International Agricultural Research
DDS	Dietary Diversity Score
EDS-RDC	Enquête Démographique et de Santé en. République Démocratique du Congo (Demographic and health survey in the Democratic Republic of Congo)
DGD	Directorate General for Development Cooperation
DRC	Democratic Republic of the Congo
ENA	Emergency Nutrition Assessment (Software)
FAO	Food and Agriculture Organization
HAZ	Height-for-Age z-Score
HH	Household
HHS	Household Hunger Scale
HT-CIALCA	Consortium for Improving Agriculture-based Livelihoods in Central Africa
IYCF	Infant and Young Child Feeding
IITA	International Institute of Tropical Agriculture
IPC	Integrated Food Security Phase Classification
MICS	Multiple Indicator Cluster Survey
MDD-W	Minimal Dietary Diversity for Women of Reproductive Age
MSF	Médecins Sans Frontières
NGO	Non-governmental Organization
NLIS	Nutrition Landscape Information System
OFSP	Orange-fleshed Sweet Potato
PSC	Pre-school aged Children
PRONAUT	Programme Nationale de Nutrition

RDR	Relative Dose Response
R4D	Research-for-Development
RBP	Retinol-binding Protein
SR	Serum retinol
SD	Standard deviations
RNI	Recommended Nutrient Intake
UNAIDS	United Nations Programme on HIV/AIDS
UNICEF	United Nations International Children's Emergency Fund
VAD	Vitamin A deficiency
VA	Vitamin A
VMNIS	Vitamin and Mineral Nutrition Information System
WAZ	Weight-for-Age z-Score
WHZ	Weight-for-Height z-Score
WFP	World Food Program
WHO	World Health Organization
WRA	Women of Reproductive Age
WDDS	Women´s Dietary Diversity Score
WHO/TDR	World Health Organization’s Special Programme for Research and Training in Tropical Diseases

7.4 Tables

Table 7: Prevalences of the reference child´s (6-24months of age) health status (N=207)

Child: Gender	Female	53,6%
	Male	46,4%
Child: Oedema (yes/no)	Yes	3,9%
Child: Skin condition (good/not good)	Not good	14%
Child: Hair condition (good/ not good)	Not good	19,3%
Child: Was it sick for the last one month…	Yes	68,6%
…if so, did it receive any form of treatment?	Yes	62,8%
Child (6-24months old): Breastfed during the last 6 months? (yes/no)	Yes	47,8%
Child (6-24months old): Currently breastfeeding? (yes/no)	Yes	66,2%
Mother: Sick for the last one month…	Yes	48,3%
… if so, did receive any form of treatment?	Yes	85%
Child: Wasted (weight for height z-score)	severely	2,6%
	moderately	5,5%
	Not wasted	91,9%
Child: Stunted (height for age z-score)	severely	7,2%
	moderately	20%
	Not wasted	72,1%
Child: Underweight (weight for age z-score)	severely	9%
	moderately	14,5%
	Not wasted	76,5%

Table 11: Cross tabulation of vitamin A rich food groups and the most consumed food group (white roots, and tubers) against the number of food groups consumed by mothers (WDDS) and children (DDS*)*

Food groups	WDDS* 1-6						DDS* 1-6					
	1	2	3	4	5	6	1	2	3	4	5	6
White roots, tubers (%)	5 (2,6)	62 (32,3)	58 (30,2)	29 (15,1)	31 (16,1)	7 (3,6)	3 (1,9)	52 (32,5)	53 (33,1)	22 (13,8)	28 (17,5)	2 (1,3)
Dark green leafy vegetables (%)	2 (1,1)	61 (33)	53 (28,6)	31 (16,8)	31 (16,8)	7 (3,8)	3 (2)	47 (31,1)	49 (32,5)	24 (15,9)	26 (17,2)	2 (1,3)
Vitamin A rich vegetables, roots, tubers (%)	1 (2,9)	2 (5,9)	13 (38,2)	5 (14,7)	8 (23,5)	5 (14,7)	5 (11,9)	17 (40,5)	13 (31)	5 (11,9)	2 (4,8)	0

Vitamin A rich fruits (%)	0	0	0	1 (50)	1 (50)	0	0	1 (20)	2 (40)	2 (40)	0	0

** WDDS= Women´s Dietary Diversity Score; DDS= Dietary Diversity Score child*

Table 14: Usage and contribution of animals owned by households (N=207) to income and consumption

	Guinea pig	Pig	Hen	Rabbit	Goat	Other animal	No animal
HH% (N=207)	37,2 (N=77)	13,0 (N=27)	19,8 (N=41)	12,1 (N=25)	18,8 (N=39)	4,3 (N=9)	37,7 (N=78)
Use of animal*							
Food%	67,5	3,7	36,6	4,0	0	0	-
dung fuel%	5,2	14,8	0	0	5,1	0	-
Fertilizer%	40,3	40,7	26,8	48,0	43,6	55,6	-
Sale%	3,9	33,3	43,9	48,0	59,0	0	-
Smearing%	0	0	0	0	0	0	-
not applicable%	2,6	7,4	0	4,0	0	11,1	-
Others%	1,3	0	0	0	0	0	-
Use of meat*							
HH consumption%	87,0	3,7	61,0	76,0	2,6	-	-
Sale%	0	29,6	7,3	4,0	23,1	-	-
Sale+ consumption%	7,8	11,1	7,3	4,0	7,7	-	-
Use of eggs*							
HH consumption	0	0	73,2	0	0	-	-
Sale	0	0	14,6	0	0	-	-
Sale + consumption	0	0	9,8	0	0	-	-
Contribution of animal species to food consumption*							
major	11,7	3,7	17,1	0	2,6	-	-
medium	16,9	7,4	17,2	12	10,3	-	-
minor	59,7	18,5	48,8	68	23,1	-	-
none	10,4	40,7	12,2	16	46,2	-	-
Contribution of animal species to income*							
major	7,8	7,4	9,8	4	7,7	-	-
medium	1,3	7,4	7,3	8	23,1	-	-
minor	32,5	25,9	53,7	56	33,3	-	-
none	42,9	29,6	29,3	24	30,8	-	-

** evaluated from the number of households that own the named animal species*

Table 15: Cross table chi^2 test to test for a statistically significant relationship between shown independent factors

Relationships between groups *		Pearson Chi^2
HH-Hunger Score	Estimated total off-farm income/month	0,000*
HH-Hunger Score	Classification of stunting, underweight and wasting	0,171
HH-Hunger Score	BMI Mother	0,129
Educational level of mother	Exclusively breastfed child during first 6 months	0,036*
Educational level of mother	Immunization/vitamin A status child	0,971
Educational level of mother	Classification of stunting, underweight and wasting	0,856
Educational information received on how to feed child	Exclusively breastfed child during first 6 months	0,157
Educational information received on how to feed child	Classification of stunting, underweight and wasting	0,973
Exclusively breastfed child during first 6 months	Classification of stunting, underweight and wasting	0,950
Classification of stunting, underweight and wasting	Estimated total off-farm income	0,572
Classification of stunting, underweight and wasting	Territories Kabare and Walungu	0,234
WDDS DDS child	Total off-farm income	0,079 0,232
DDS child	Classification of stunting, underweight and wasting	0,7

** Association between two variables is statistically significant if asymptotic significance (2-sided) < p=0.05*